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Volume 38. SEPTEMBER, 1924. $4.00 a Year.
Number 3. $1.25 a Number.

JOURNAL

OF THE

New England Water Works Association.

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PUBLISHED BY
THE NEW ENGLAND WATER WORKS ASSOCIATION,
714 Tremont Temple, Boston, Mass.

Entered as second-class matter September 23, 1903, at the Post Office at Boston, Mass., under Act of Congress of March 3, 1879.

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1924—1925.

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THE ASSOCIATION was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of 800 men. Its membership is divided into six classes, viz:

A Member shall be an officer or employee of a public or private water works, an engineer, chemist or other person qualified to aid or interested in the advancement of knowledge relative to water works.

An Honorary Member shall be a person of acknowledged eminence in some branch of water supply or of engineering.

A Life Member shall be a member whose service to the Association entitles him to special recognition by the Association.

A Junior shall be not less than eighteen years nor more than twenty-five years of age, a student or connected with water supply work.

An Associate shall be either a person, firm or corporation engaged in manufacturing or furnishing materials or supplies for the construction or maintenance of water works.

A Corporate Member shall be either a Water Board, Commission, Company or Municipal Corporation.

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Associates	10.00	Associates	20.00
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This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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New England Water Works Association

ORGANIZED 1882.

Vol. XXXVIII. September, 1924. No. 3.

This Association, as a body, is not responsible for the statements or opinions of any of its members.

INFILTRATION GALLERIES AT THE DES MOINES, IOWA, WATER WORKS

BY CHARLES B. BURDICK.*

[*Read October 1, 1924.*]

The Des Moines water supply will probably interest water-works men, because it typifies a source of supply but seldom successfully employed. It is one that has demonstrated its practicability through about fifty years of use, more particularly within the last fifteen years, during which the draft of water has been tripled.

The water is obtained through a system of collecting galleries, which constitute a horizontal well, so to speak, two miles in length, tapping a coarse sand stratum 15 to 20 ft. in thickness. As will be shown, the water is derived almost entirely from infiltration from the Raccoon River, which roughly parallels the gallery system at a distance, generally, from 150 to 200 ft. The average daily pumpage at present is approximately 12 million gal. The water is pumped from the gallery system directly into the city mains without storage and without secondary pumping. The gallery system has the ability to supply all peak drafts up to a present required peak rate of 26 million gal. per day, measured by the domestic and fire-protection requirements.

It is proposed to show the fundamental principles of this supply, the conditions that make it possible, and the quantity and quality of the water obtained.

City of Des Moines.

The present population of Des Moines is approximately 145 000. The growth has been comparatively uniform and moderate, from 11 000 in 1870, about the time the water works was built. The average daily pumpage was 1.7 m.g.d. in 1884 and 3.2 m.g.d. in 1905. During the year 1923 pumpage rates were as follows:

Average twenty-four hours	11.8 m.g.d.
Maximum eight-hour rate	19 m.g.d.
Estimated peak for domestic requirements and fire protection	26 m.g.d.

* Of Alvord, Burdick & Howson, Engineers, Chicago.

FIG. 1. — MAP SHOWING PRESENT AND PREGLACIAL VALLEYS OF THE DES MOINES AND RACCOON RIVERS, AT DES MOINES, IOWA

Local Geology.

Des Moines is located at the junction of the Des Moines and Raccoon rivers. The latter stream on which the water works is located has a drainage area of 3 677 sq. miles. It has a minimum flow of 50 to 100 sec. ft. This locality lies in the coal measures. The surface soil is heavy clay. The underlying rocks are limestones, shales, and sandstones, of no significance so far as this water supply is concerned.

In geological times the water from the melting glaciers eroded wide and deep channels in the impervious clays, constituting the surface materials. With the recession of the glaciers and the diminished water supply therefrom, these immense river channels were largely backfilled with the sands and gravels brought down by the receding glacial water. As seems to be common in such cases the coarser and heavier materials were deposited first, followed by the finer sands, and at a still later time a deposit of sandy soil. The Raccoon River now threads a tortuous course back and forth across the bottoms. The modern river has cut through the surface soils, and runs practically upon the top of the sand and gravel stratum which underlies the bed of the river 15 to 20 ft.

The Des Moines Water Works is located about one mile from the mouth of the Raccoon River. The collecting galleries extend thence parallel to the river upstream for a distance of about two miles. At the place of development the ancient valley of the Raccoon River is about one mile in width. The bottom and sides of the ancient channel are formed by impervious clays.

Figure 1 is a plat of the alluvium deposited in the Raccoon and Des Moines River Valleys. Plate I is a plat with cross-sections, showing the extent and character of the alluvium from the Des Moines Water Works upstream to Valley Junction, a distance of about three miles.

History of Supply.

The Des Moines Water Works was completed in the winter of 1871-72. The water was obtained from a circular well on the north bank of the river about 12 ft. in diameter and 14 ft. deep. As the quantity drawn was small, it was probably largely pure ground water. The pumping plant was located about seven hundred feet north of the river. The water was drawn through a suction pipe and discharged directly into the mains. In 1876 two additional similar wells were built.

In 1882 a brick well 50 ft. in diameter and 30 ft. deep was sunk at the pumping station. It furnished only about 500 000 gal. per day. The supply was immediately supplemented by a wooden collecting gallery about 5 ft. wide and 4 ft. high, extending from the bottom of the well toward the river, and upon reaching the river bank turning upstream and closely paralleling the same. This gallery was open on the bottom, with open cracks between the planks on the sides, and was surrounded for a few

inches with screened gravel. In 1897, 2 319 ft. of gallery were in use, supplying an average of about 2.5 m.g.d. In 1905 an additional gallery 1 000 ft. in length was constructed, extending from the north bank of the river at right angles to the stream and crossing same, a total length of 1 000 ft. This gallery was connected to the suction well by a 36-in. siphon 600 ft. in length, which operated successfully for fifteen years.

During the greater part of the time the gallery furnished sufficient water for the requirements of the city. It was the custom, however, in emergencies to draw directly upon the river when necessary, in extreme droughts, or in fighting a large fire.

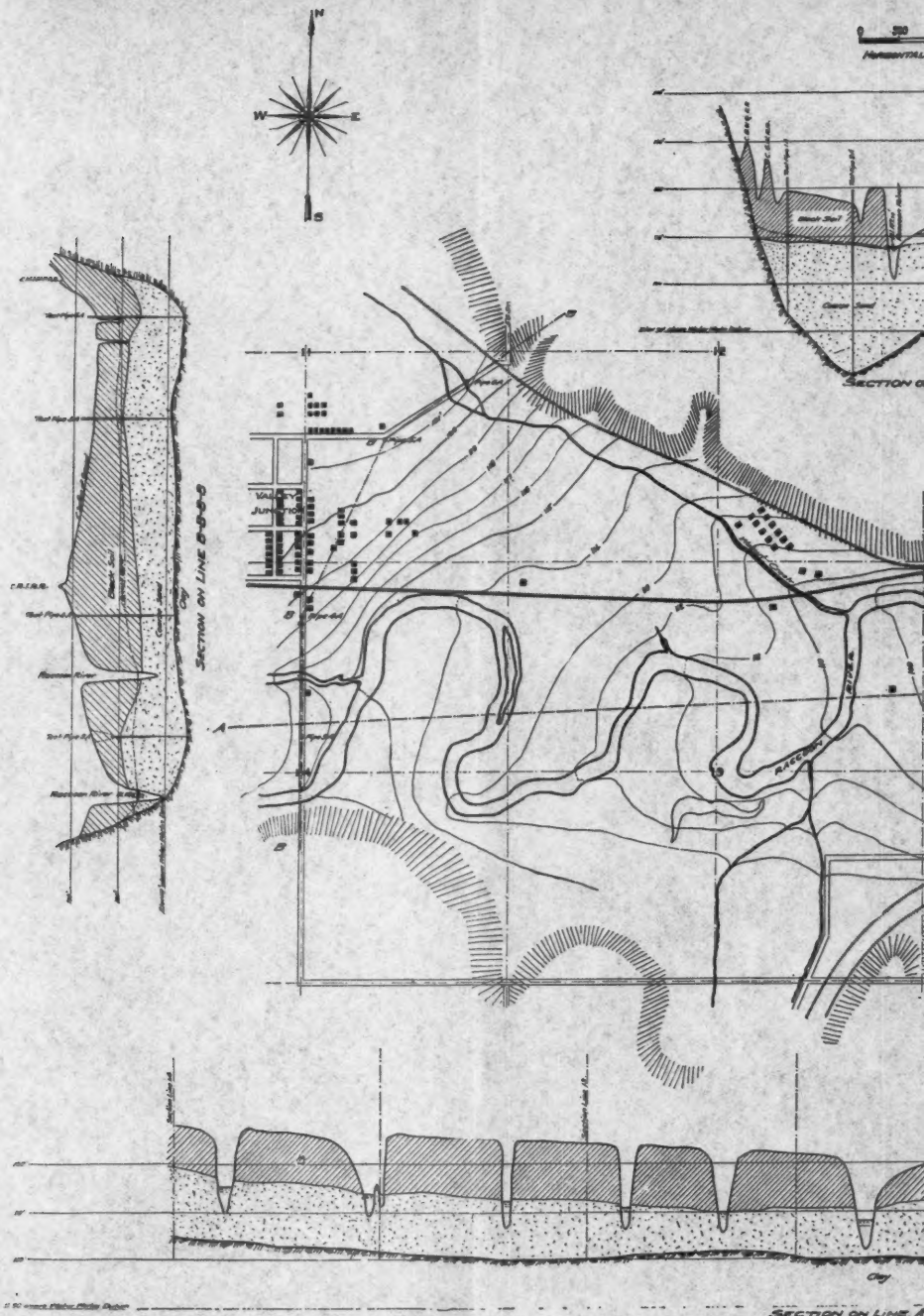
Investigation of 1907.

In 1907, the growth of the city demanding additional water, a thorough investigation was made as to the source of supply and the best means to increase it. Up to this time it was supposed that a ground water was being developed, derived from rainfall without important additions of infiltered river water. At this time the average daily pumpage was about 3.5 m.g.d.

The bottom lands from the water works up to Valley Junction, a distance of three miles, were surveyed; test borings were made to disclose the character of the alluvium, and in which water levels could be observed (see Plate I). The investigation showed, except in the vicinity of the collecting galleries, that the ground water stood above the river surface under the land, and, in general, flowed toward the river, the axis of flow pointing slightly downstream. In the vicinity of the collecting galleries, however, the ground water contours were depressed several feet below the surface of the river.

Evidently, if the supply was derived from rainfall, falling directly on the land, there must be a sufficient gathering area to furnish the supply drawn, and an adequate transmission capacity in the underlying sands to carry it from the place gathered to the place collected. The investigation showed that the gathering area, between the water works and Valley Junction, is about 3 sq. miles. If one third of the rainfall should enter the soil and could be transmitted to the collecting works, it was estimated that the supply produced would not exceed 1.5 m.g.d., or about one half of the pumpage of that time.

The transmission capacity of the underlying sands was investigated by making numerous borings and determining the depth and effective sizes of the sand, and the average ground water slope. This information indicated that the average available slope parallel to the river valley was about one foot in 1 160, the effective size of the sand 0.42 mm., and the porosity was found to be approximately 0.33. From these data, it was estimated that the downstream travel of the water in the sand was about 1.3 ft. per day, which in the total cross-section of the valley available would produce not to exceed 185 000 gal. per day, or less than $\frac{1}{20}$ of the pumpage



PLAN AND CROSS SECTIONS OF RACCOON

PLATE I.

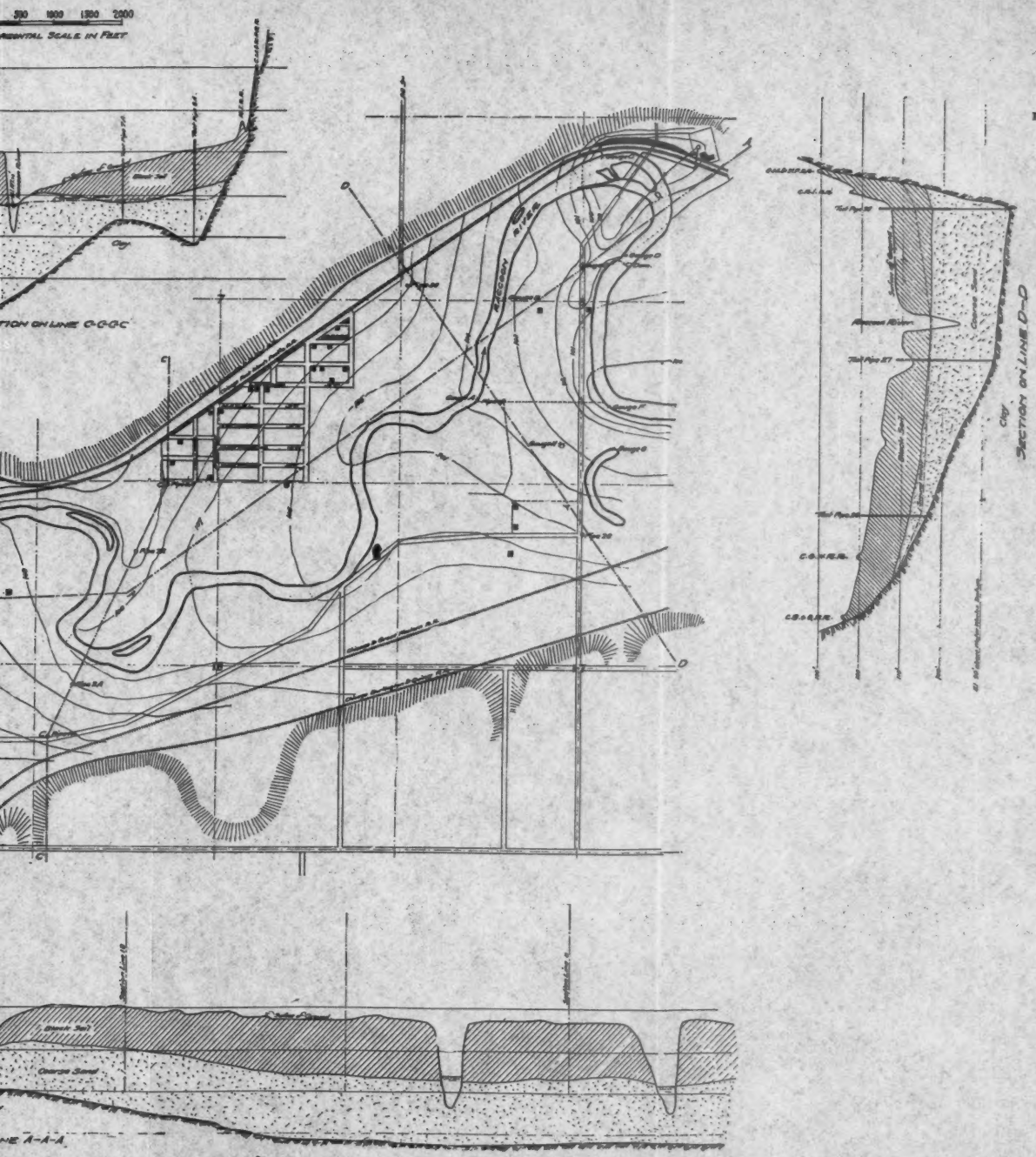
N. E. W. W. ASSOCIATION.

VOL. XXXVIII.

BURDICK ON

INFILTRATION GALLERIES AT THE

DES MOINES WATER WORKS.



ON RIVER VALLEY SHOWING GROUND WATER CONTOURS.

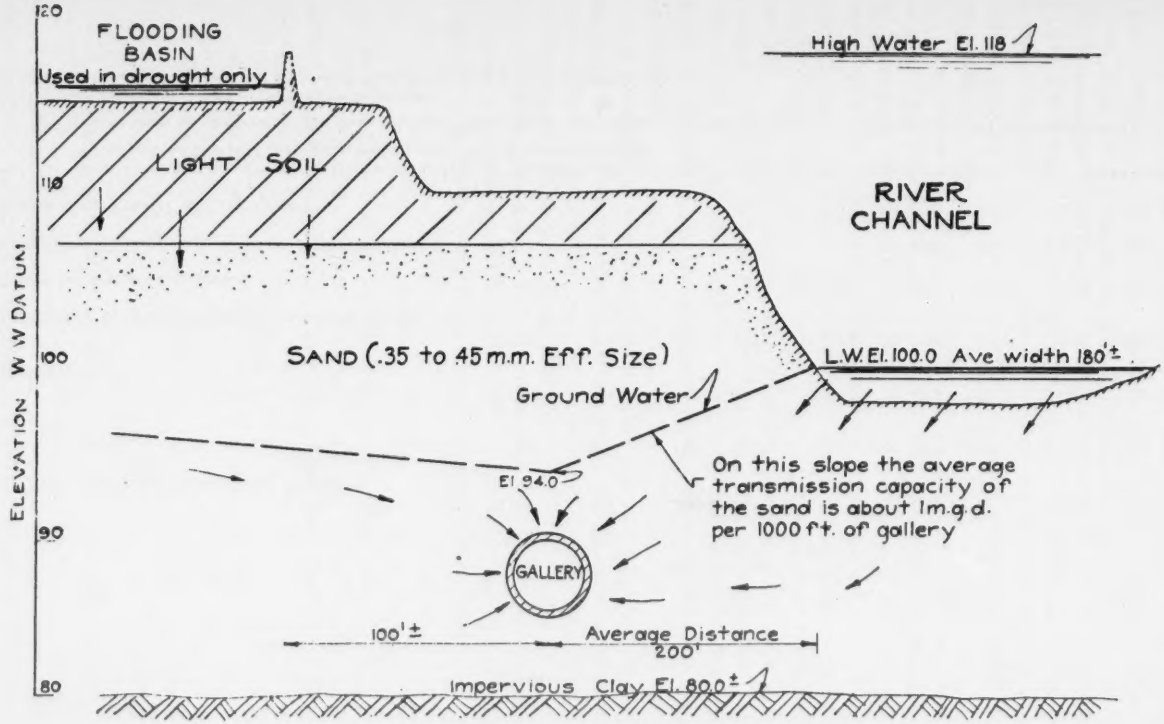


FIG. 2. — TYPICAL SECTION OF FILTER GALLERY.

TABLE No. 1.

ANALYSIS OF WATER SUPPLY IN CRITICAL PERIODS OF DROUGHT.

Drought Period.	Pumpage.		Water Stages, Lowest.		Length of Gallery.	River Subject to Infiltration.		Yield in Feet of River.	
	Average Daily for Year. M.G.	Average Daily for Max. Mo. M.G.	River.	Suction Well.	Feet.	Feet.	Acres.	Per M.G.	Per Acre.
1907 Irrigated Bars, and Used Some River Water	3.69	4.1	103	95.6	3 319	3 000	*14.0 †20.	900	*260 000 †185 000
1910 Irrigated Bars.	5.04	5.7	102	95.8	4 819	4 000	*18.7 †24.	790	*270 000 †210 000
1914 Used Emergency Filter.	6.13	7.0	101	96.5	6 644	6 300	*27.0 †31.	1 030	*228 000 †198 000
1916 Used Emergency Filter and Irrigated Land with Pump.	7.00	8.0	100	95.6	8 479	7 700	31.8	1 100	220 000
Available now for Future Droughts	8.5	...	...	....	10 134	9 700	38.5	1 140	220 000
Available Supply with Boganwright Tract Fully Developed	12.0	...	...	....	.....	14 200	54.5	1 180	220 000
Available with Polk Tract Fully Developed	21.0	...	...	....	.....	26 800	95.5	1 270	220 000

NOTE: (*a*) With new dam at present dam site with crest at elevation 103, 14 acres would be added to filtration area. This would produce 3.1 m.g.d. at 220 000 gal. per acre and add 36% to present supply.

(*b*) A 3-ft. dam at the foot of the Boganwright Tract would add about 9 acres, or 2 m.g.d. The area would be increased 56%.

*Based on present areas — formerly they were somewhat greater.

†Based on acreage increased to correspond with former water levels, using present topography.

at the time. It thus became evident that the greater part of the water must have been derived from another source.

The investigation further indicated that the ground water contours were depressed below the river surface for a length of about 7 000 ft. of river, although through most of this distance the depression or negative head was comparatively slight. It was estimated that an average filtration rate of 100 000 gal. per acre of river bed per day, in that portion of it subject to negative head, would be sufficient to account for the pumpage at the time. Records of leakage from canals frequently show much higher rates of infiltration than this.

There was other circumstantial evidence that the supply was derived largely from river infiltration. At times of high water the difference in level between the river and the water in the suction well was one foot or less. At times of low water this difference often reached 5 or 6 ft. At certain times the floods would leave the gravel bars adjoining the river more or less coated with silt. From this occurrence the lost head was increased. When the water levels in the gallery receded so low as to be considered dangerous, it had been the custom to "irrigate the river bars," that is, to open channels in them. This materially increased the gallery water levels, diminishing the difference between same and the water surface in the river.

As a result of this investigation, after considering other sources of supply it was determined that additional supply should be developed, upon the principle of river infiltration, by extending the gallery parallel to the river and subjecting adequate areas of river bed to the negative head necessary to induce filtration. This determination was made after a study of the quality of the water that had been produced and the nature of the underlying materials in which galleries necessary would be built.

Present Supply.

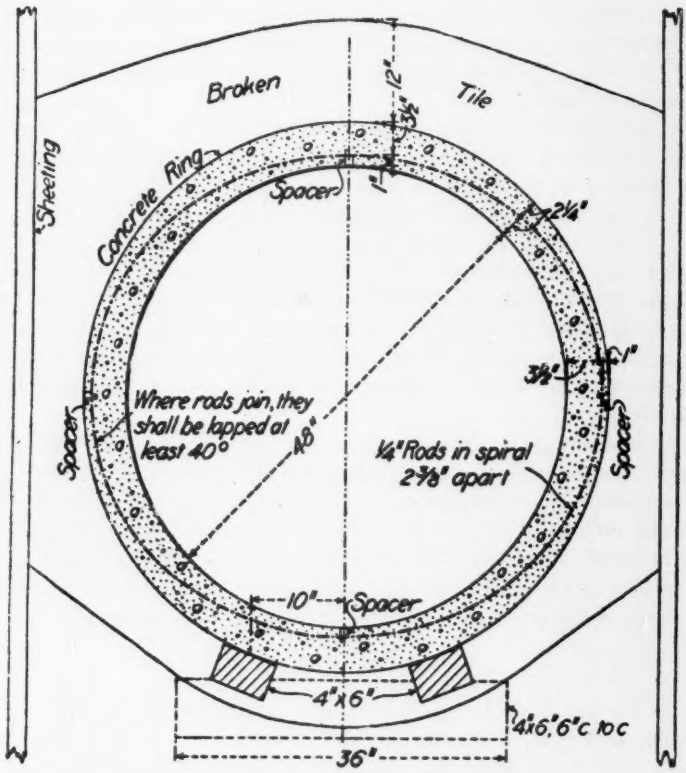
At the end of 1923, 10 144 ft. of collecting gallery was in use.

The new gallery extends upstream from the end of the old wooden gallery, No. 4 (see Plate II). Extensions have been made from time to time as follows:

Completed in 1910	1 500 ft.	
Completed in 1911	1 845 „	
Completed in 1917	3 480 „	
		6 825
Old Gallery		3 319
Total gallery in use 1917 to 1924		10 144

The new gallery consists of reinforced concrete rings or tiles 4 ft. in diameter, 2 ft. long, and 4 in. in thickness. These rings are laid on timber cradles to insure perfect alignment, and are laid butt to butt, leaving a $\frac{1}{4}$-in.

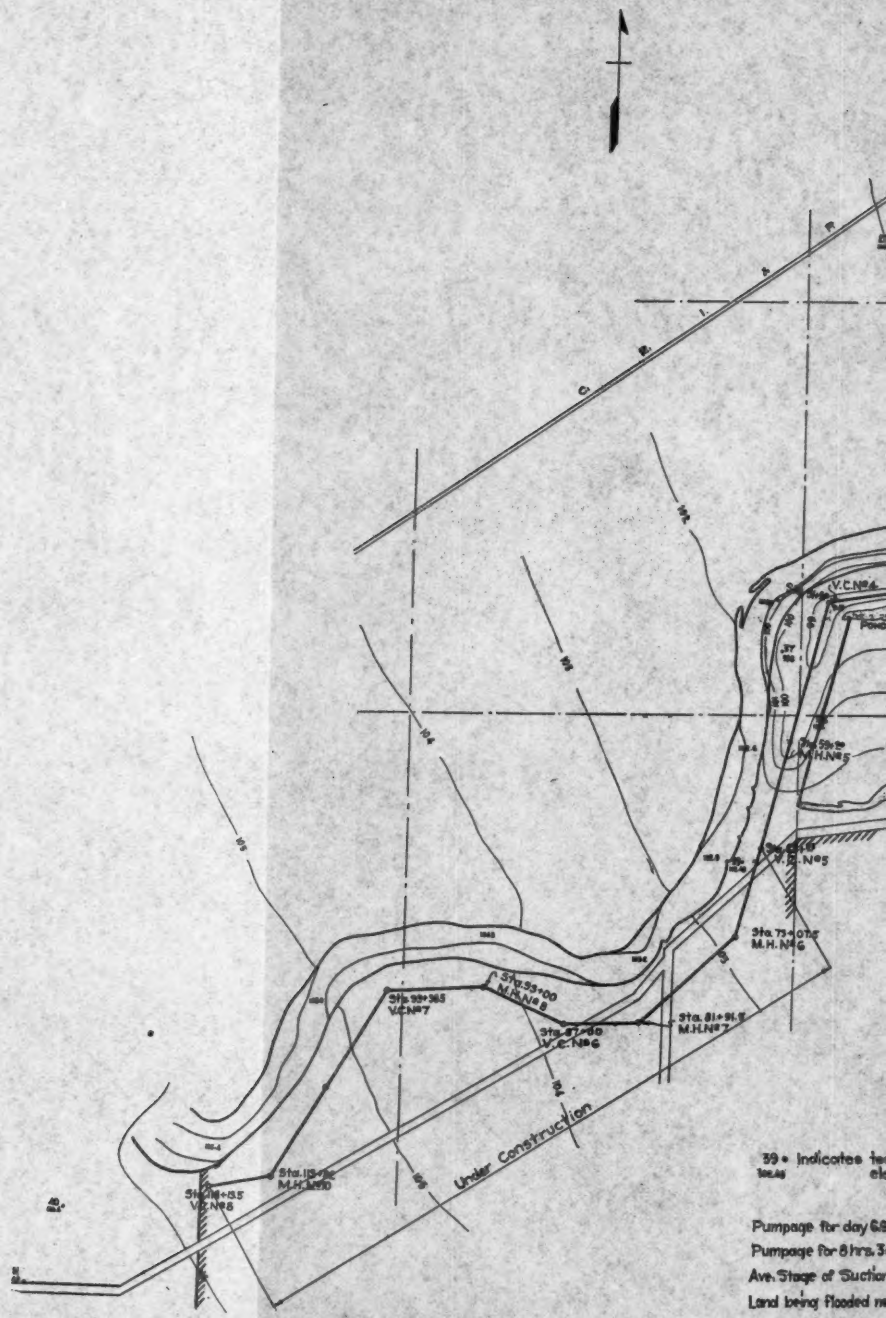
space between rings, kept uniform by four lugs cast on each ring. After the rings are placed, the space between the ring and the sheeting, and above and below the ring, is surrounded by screened gravel having a thickness of 8 to 12 in. The trench is then filled with the excavated sand and



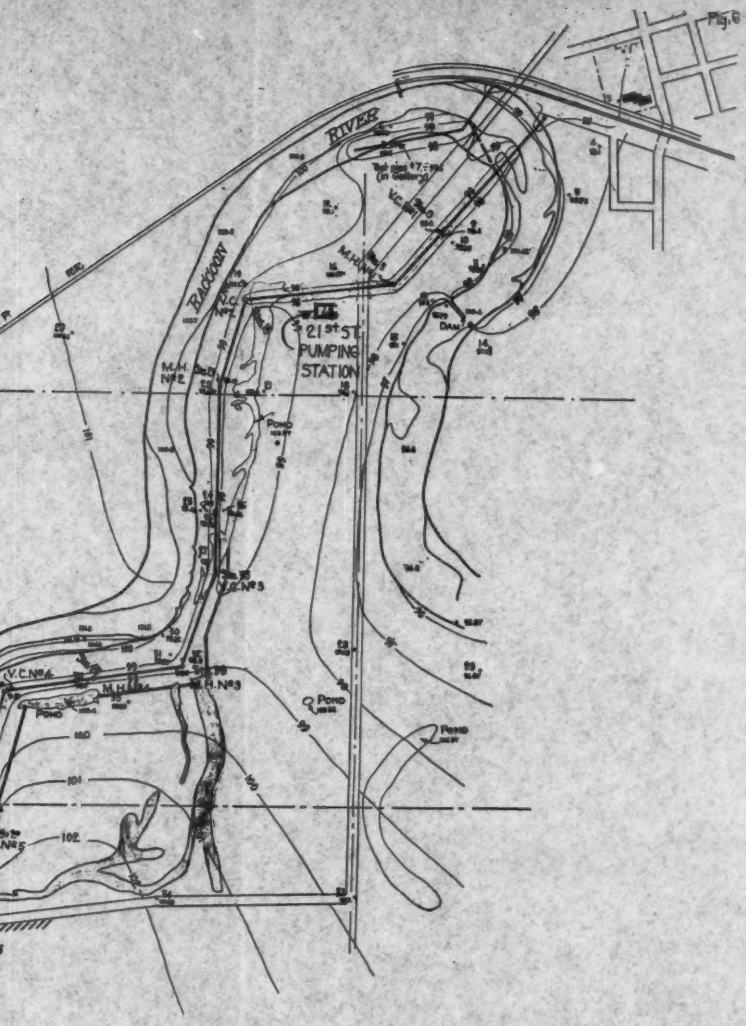
Reinforced Concrete Gallery

FIG. 3.

the sheeting withdrawn (see Fig. 3). The bottom of the gallery conduit is about 14 ft. below the low-water surface of the river. It roughly parallels the river bank at a distance of 150 to 200 ft. The necessary depth of cutting has varied from 25 to 35 ft. Manholes are located at all bends extending above high water surrounded by embankments of sand, to protect against leakage of polluted water. Gate valves dividing the gallery into sections facilitate repairs. As yet no repairs have been necessary.



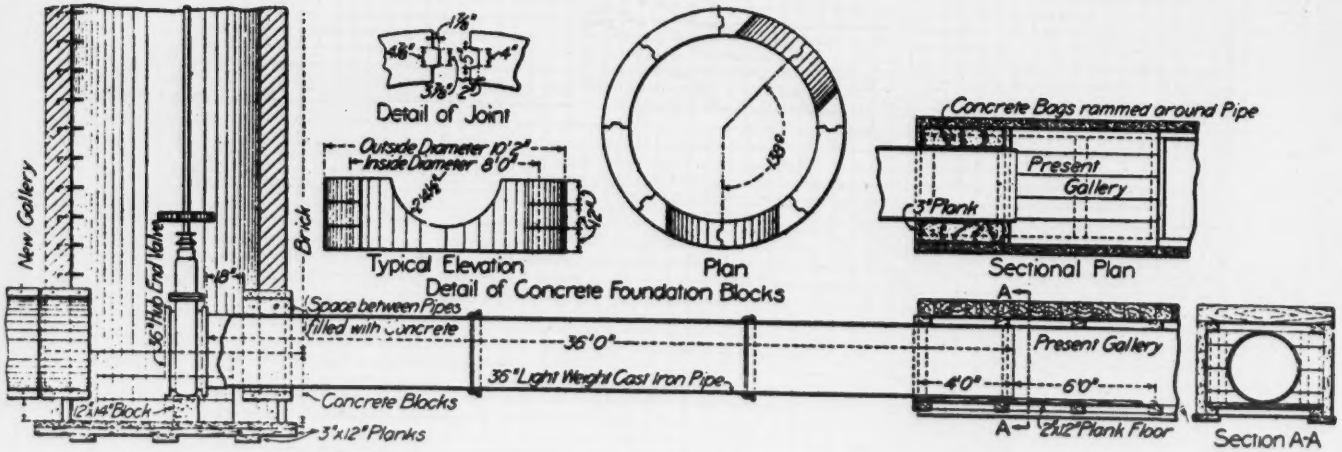
Note: Ground Water Contours are shown for operation



cates test-hole.
elevation of ground water.

r day 6.94 million gallons.
r 8 hrs. 3.9 million gallons. (8 A.M. - 4 P.M.)
f Suction Well 98.0
Flooded near Station 33 at rate of 35 M.G.D.

ation of Gallery up to Station 51+60.



Details of Connection of Gate Chamber 1 and Present Gallery

FIG. 4.

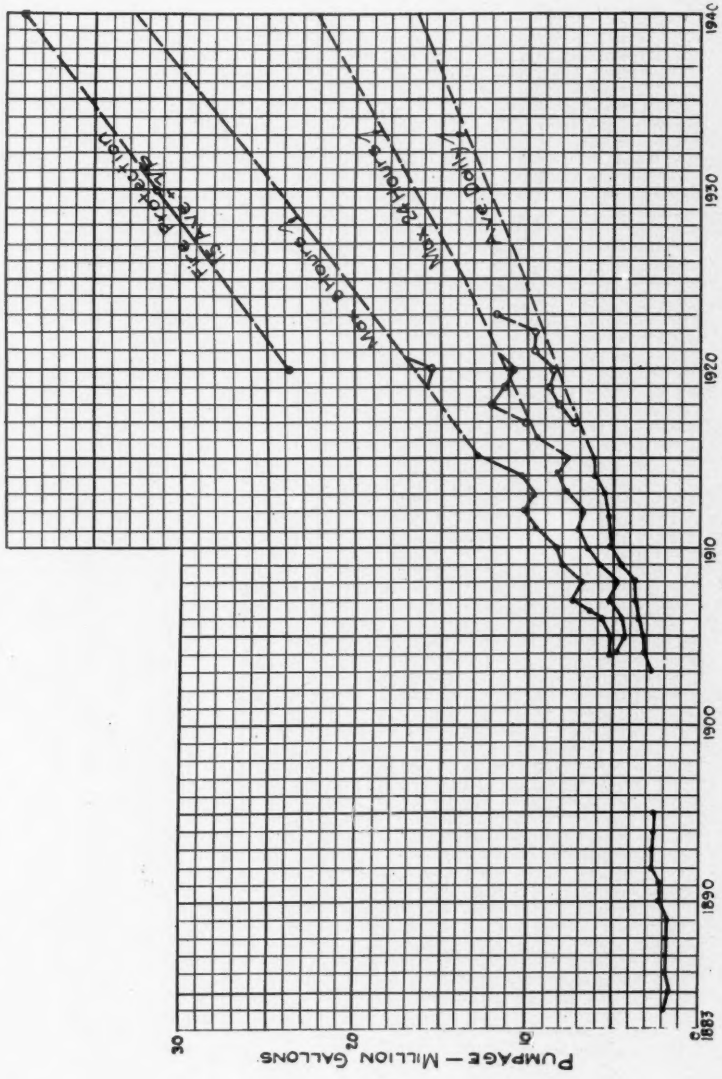


FIG. 5. — DES MOINES WATER CO. DIAGRAM SHOWING PAST AND ESTIMATED FUTURE PUMPAGE.

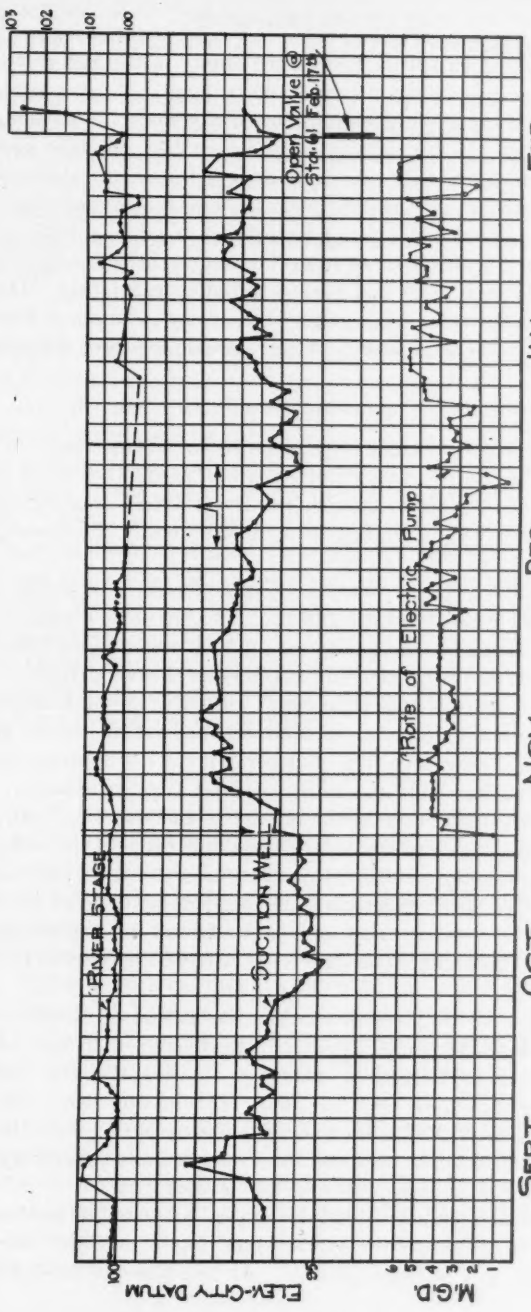


FIG. 6. — DES MOINES WATER CO. DIAGRAM SHOWING RELATION OF RIVER, GALLERY STAGE AND LAND FLOODING, WINTER OF 1916–17.

Gallery Capacity.

Experience up to 1916 indicated the ability of the gallery to produce about 1 million gal. daily for each 1 100 ft. length of river subjected to negative head, during the governing drought periods. This is equivalent to about 220 000 gal. per day per acre of river bed. Future additions to the supply planned at that time were designed upon the above basis. It was then estimated that the old gallery system, supplemented by the new gallery up to Station 6825, would furnish 8.5 m.g.d. In 1923 an average draft of 11.8 m.g.d. was secured from this system through a more extensive use of land flooding than had been resorted to previously. During the daylight hours the rate of pumpage, particularly in summer, occasionally reached 20 m.g.d., and greater peak rates could have been accommodated.

Land Flooding.

Reference has previously been made to the former practice of " irrigating the river bars " at periods of low water, particularly when they were coated with silt. Thus to disturb the river surface was regarded as of doubtful desirability, as tending to stimulate unduly the filtration at the point disturbed.

In seasons of ordinary wetness, the practicable draft is only governed by the carrying capacity of the gallery. The practicable capacity thereof has been governed by the ability to produce water in extreme drought periods; sometimes only occurring at intervals of several years.

About ten years ago the experiment was tried, during a critical period, to pump river water out upon the land, on the land side of the gallery, so controlling the flooded area that, in general, it did not approach the gallery closer than 100 ft. This experiment proved very satisfactory. It produced no noticeable change in the quality of the water and proved to be a means by which gallery water levels could be brought up to any desired elevation by pumping a sufficient quantity of water upon the land.

The surface area underlying the flooded land varies in character. None of it is pure sand; most of it is sandy soil interspersed with some pockets of gumbo which, upon inspection, would be deemed to be relatively impervious.

In the fall of 1922, which was the last period of excessive drought, water was pumped on the lands nearly continuously at the rate of 5 m.g.d. from September to December, inclusive. During the year 1922, 1 293 million gal. were pumped upon the land. This is equivalent to 3.55 m.g.d. for the entire year, or 35% of the average pumpage of the year. In ordinary seasons the land-flooding has been less extensive, and practically no land-flooding has been necessary during the present year.

In the drought period of 1922 the acreage subjected to flooding reached a maximum of 13 acres; the average unit rate of filtration was approximately 385 000 gal. per acre per day. At this time the flooded lands had

not been cleaned since first used, six or eight years earlier. Weeds had been kept cut. Surfaces which were not in use were more or less covered with sod.

Following the drought of 1922, additional flooding areas were prepared and the acreage formerly flooded was cleaned by shovels and wagons.

The engineers for the water department regard the flooding of lands rather as an emergency matter to tide over drought periods. It is believed, however, that the practice can be extended, thus making the gallery collecting system somewhat more capacious than it has been considered to be in the past.

Storage.

One of the important advantages of the present gallery system is the ability to produce water at a very high rate for short periods to meet the peaks of water demand, including fire protection. This ability arises from the practice of maintaining a water level several feet above the top of the galleries under ordinary circumstances, thus storing water in the sand in close proximity to the gallery, which can be drawn upon to meet the peak rates. This storage — assuming that water in the amount of one fifth of the volume of the sand drained can be secured — is equivalent to about 6 million gal. for a strip 200 ft. wide and two ft. deep over the galleries. A much larger storage than this is actually available, particularly, as the more the gallery water is depressed, the greater is the quantity of water drawn from long distances to the right and left of the galleries. The gallery system has met all requirements of peak demand for many years without resort to direct pumping from the river.

Quality of the Water.

The water is moderately hard compared to western waters, varying from 220 to 340 parts per million total hardness, and averages about 280 parts. It contains some iron, generally less than .3 part per million. Iron deposit is noticeable when flushing the mains. It has never been of sufficient amount to cause serious complaint.

The river at present and for many years past has been seriously sewage-polluted. It has received a small portion of the sewage of Des Moines and all of the sewage of Valley Junction, three miles upstream; population, 3 631. The bacterial content usually runs from 10 000 to 20 000 per c.c., although it sometimes falls to one or two hundred for a few weeks in the cold season.

The water from the gallery system is clear and colorless at all times. It normally contains from 5 to 14 bacteria per c.c. on agar at 37°. *Coli* are occasionally present in 1 c.c. As a precautionary measure, the water has been chlorinated since 1910, and is constantly observed by a full-time chemist and assistant. The water department has one of the best water-testing laboratories in Iowa.

TABLE No. 2.

EFFICIENCY OF CHLORINATION, 21ST STREET STATION, 1923. DES MOINES MUNICIPAL WATER PLANT, DES MOINES, IOWA.

Month.	Average Lbs. Cl. per Million Gal.	Bacteria per Cubic Centimeter.						Tests for Presence of Members of *B. Coli.* Group.																				
		Gelatine at 20°c.			Agar at 37°c.			Untreated.			Pump.									Tap								
		Untreated.	Pump.	Tap.	Untreated.	Pump.	Tap.	No. of Samples.	Presumptive % positive in		No. of Samples.	Presumptive % positive in					Confirmatory % positive in		No of Samples.	Presumptive % positive in					Confirmatory % positive in		
									1 c.c.	10 c.c.		10 c.c.	13 c.c.	17 c.c.	25 c.c.	50 c.c.	25 c.c. or less	50 c.c.		10 c.c.	13 c.c.	17 c.c.	25 c.c.	50 c.c.	25 c.c. or less	50 c.c.
Jan.	4.367	10.80	2.23	1.65	3.80	2.23	1.54	25	0.0	32.00	26	0.0	0.0	0.0	0.0	7.69	0.0	0.0	26	0.0	0.0	0.0	0.0	7.69	0.0	0.0
Feb.	4.453	21.17	1.04	1.38	2.39	1.52	1.52	24	4.17	29.17	24	0.0	0.0	0.0	0.0	4.17	0.0	0.0	24	0.0	0.0	0.0	0.0	4.17	0.0	0.0
Mar.	4.337	31.57	2.70	4.63	3.78	2.19	2.19	23	8.70	21.74	27	0.0	0.0	0.0	0.0	7.41	0.0	0.0	27	0.0	0.0	0.0	0.0	11.11	0.0	0.0
Apr.	4.898	39.36	1.50	1.80	3.88	1.92	1.80	24	4.17	37.50	25	0.0	0.0	0.0	0.0	4.00	0.0	0.0	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May.	5.310	70.78	1.62	1.58	4.39	1.54	1.65	23	0.0	17.39	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0
June.	4.811	36.79	1.54	1.27	6.33	1.00	1.04	24	0.0	12.50	26	0.0	0.0	0.0	0.0	3.85	0.0	0.0	26	0.0	0.0	0.0	0.0	3.85	0.0	0.0
July.	4.751	15.00	2.36	1.82	2.48	1.16	1.12	25	0.0	24.00	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug.	4.908	*	*	*	5.73	1.85	1.96	26	0.0	26.92	27	0.0	0.0	0.0	3.70	0.0	0.0	0.0	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sept.	5.103	173.25	2.22	2.89	14.54	0.92	1.33	24	4.17	16.67	24	0.0	0.0	4.17	0.0	4.17	0.0	0.0	24	0.0	0.0	0.0	0.0	4.17	0.0	0.0
Oct.	4.889	14.19	0.78	0.78	4.48	0.82	0.85	27	0.0	48.15	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27	0.0	0.0	0.0	0.0	3.70	0.0	0.0
Nov.	4.876	28.48	0.96	0.80	5.25	1.08	0.96	25	0.0	16.00	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25	0.0	0.0	0.0	0.0	4.00	0.0	0.0
Dec.	4.900	9.36	1.16	1.20	4.92	1.56	1.24	25	0.0	24.00	25	0.0	0.0	0.0	0.0	4.00	0.0	0.0	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean.	4.810	32.82	1.58	1.74	5.16	1.48	1.44	24.6	1.69	25.76	25.6	0.0	0.0	0.33	0.33	2.93	0.0	0.0	25.6	0.0	0.0	0.0	0.0	3.26	0.0	0.0

*20° incubator out of order.

TABLE No. 3.

DES MOINES MUNICIPAL WATER PLANT, LABORATORY DEPARTMENT. TYPHOID FEVER DEATHS, DES MOINES, IOWA.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Population in Thousands.	Rate per 100 000.
1905....	1	1	1	..	..	1	2	2	2	2	2	..	14	76	18.4
1906....	2	2	2	..	..	..	2	1	1	2	..	1	13	78	16.7
1907....	..	..	1	1	2	3	4	3	3	3	3	3	25	80	31.3
1908....	..	1	1	..	2	1	1	4	1	2	2	1	16	82	19.5
1909....	2	2	..	..	2	..	..	2	2	1	2	2	15	84	17.9
1910....	1	..	..	1	..	..	1	2	4	1	2	16	28	86	32.6
1911....	6	2	..	..	2	..	1	2	1	2	1	..	17	90	18.9
1912....	..	2	1	..	..	..	..	..	3	..	1	2	9	92.5	9.7
1913....*	1	1	..	..	..	1	..	2	3	2	1	..	11	95.5	11.5
1914....	2	..	..	..	1	..	1	..	3	1	1	4	13	98.0	13.3
1915....	..	1	1	3	1	..	1	2	4	2	2	3	20	105	19.0
1916....	..	..	..	1	1	..	..	..	..	..	..	..	2	108.6	1.85
1917....	..	..	..	..	..	..	1	..	2	1	2	2	8	112.6	7.1
1918....	1	1	2	..	1	..	4	..	4	1	..	..	14	120 (Camp	11.7
1919....	1	..	1	..	2	..	..	..	1	1	1	2	9	125 Dodge*	7.2
1920....	..	..	..	..	1	..	..	1	1	..	..	..	3	126	2.38
1921....	..	..	..	..	..	..	..	..	..	1	..	..	1	129	0.775
1922....	..	..	..	..	..	..	..	..	..	1	..	..	1	135	0.74
1923....	..	..	..	..	..	1	..	..	..	..	..	..	1	140	0.71

*In addition.

Table 2 is a summary of bacterial results for 1923. Table 3 shows the typhoid cases for the past twenty years. As chlorinated, the water compares with the best filtered water, and the typhoid history, especially in recent years, has been very satisfactory. Only three deaths occurred in the three years past, and these are believed to have had no connection with the water supply.

Estimated Cost of Gallery System and Water Produced.

As construction work has progressed over a period of forty years, it is impossible to present accurate figures of cost. The property, however, was appraised in 1912, and it is possible to present these figures, supplemented by expenditures since that day. The appraised value of the old construction, plus the construction cost of the new work, and including about 200 acres of land accommodating and protecting the gallery system up to Station 6825, is approximately $405 000.

The cost of the water developed is estimated as follows, for the year 1923, during which 4 300 mg. were pumped into the city mains.

		Total.	Per M.G. Developed.
Interest and Depreciation at 6%.		$24 300	$5.66
Operating Expense.			
Care and Protection of Water Supply, including Laboratories and Supervision	$16 285		
Power	3 307		
	$19 592		
Less Profit on Farm Operations	1 736		
		17 856	4.15
		$42 156	$9.81

Although the construction estimated above was largely done pre-war, a 5 000-ft. extension to the gallery system, nearing completion at the present moment, is being carried out at a construction cost of approximately $30 per foot of gallery, which only slightly exceeds the prior construction costs. The above figures therefore may be taken as roughly representing cost at the present time.

SOURCES OF SUPPLY, CONDUITS AND RESERVOIRS, OF THE ROCHESTER, N. Y., WATER-WORKS SYSTEM.

BY JOHN F. SKINNER.*

[*Read September 30, 1924.*]

Seventy-one years ago the Mayor of Rochester, in his Inaugural, said, " It is hoped that our citizens will soon feel the necessity of supplying our city with water by some means, both for their health and convenience."

Six years later a communication was sent to the Mayor by the Hon. Elisha Johnson, which outlined a plan for supplying the city with water from the watershed of Little Black Creek. He estimated a consumption of 25-gal. per capita for a population of 60 000, and proposed a reservoir in the southwestern part of the city, fed by an aqueduct of brick or stone 4 ft. in diameter, 2 miles long, and with a fall of 4 in. per mile.

In the following year, 1860, $500 was appropriated for " The survey and plans for Water Works," in accordance with which Daniel Marsh submitted a report embodying five distinct plans. They included taking water from Lake Ontario, from the Genesee River, from Black Creek, from Honeoye Creek and from Hemlock Lake, the latter in a 16-in. conduit. The Mendon ponds were also exploited as a source of supply.

In October of the same year a contract was entered into with the " Rochester Water Company." Considerable work was done in building reservoirs and in laying conduit and distribution pipes, but after many vicissitudes the Company collapsed early in 1872.

The following year the Board of Water Commissioners was organized and work on the present system was begun. The original source of supply was Hemlock Lake, a beautiful, clear sheet of water 6½ miles long, ½ mile wide, and 86 ft. deep. It lies between high hills 386 ft. above and about 30 miles south of Rochester, and receives the rainfall from 48 sq. miles of watershed.

The city also acquired. and has since exercised, the right to use the waters of Canadice Lake, its neighbor on the east. This lake is the same depth as Hemlock, about one third the area, and lies 196 ft. higher. Its watershed is 12.4 sq. miles, and its outlet stream has a watershed of 5.8 sq. miles. The combined watersheds of the two lakes and Canadice Outlet, if completely utilized, will yield about 33 million gal. per day. The annual precipitation in this region for the last 48 years has averaged 28.3 in. Our experience indicates a net yield of about 500 000 gal. per sq. mile per day from the watershed. All of this supply is not available, as extensive construction in diking would be required.

*Deputy City Engineer, Rochester, N. Y.

Surveys are now under way in anticipation of the necessity of using the waters of Conesus Lake which lies west of Hemlock Lake, and of Honeoye Lake which lies east of Canadice. They are somewhat lower than Hemlock Lake but their waters can also be obtained by gravity. Conesus Lake has a watershed of 69.06 sq. miles, and Honeoye Lake a watershed of 39.3 sq. miles. The total combined watersheds amount to 174.56 sq. miles. At the above rate, and fully utilized, this would give us 87 million gal. per day. If 75 per cent. of this amount is available during dry years we shall have available 65 million gal. per day.

Our present population is about 330 000, and it has doubled in the last 25 years. Our present use of water from this domestic system is about 86.4 gal. per capita, or a total of something over 26 million gal. per day. These figures are complicated by the fact that a small portion of our population uses Lake Ontario water supplied by a private company.

When all of the available watersheds above mentioned are reasonably utilized we shall have an ample domestic supply for more than double our present population.

About thirty years ago the city began the purchase of property around Hemlock Lake, and later around Canadice Lake.

The shores of Hemlock Lake were lined with summer cottages, and up to that time a sanitary-pail system of collection of night soil and garbage had been maintained by the city. The properties for 200 ft. from the shore were purchased, and the cottages removed. In some cases whole farms were acquired.

Plantations of conifers have since been made on the shores of both lakes, and constant inspection maintains the pristine purity of the supply.

Reservoirs.

At Rush, nine miles from the city, a storage reservoir was constructed in fill and excavation on a clay hill at the time of the construction of Conduit I. The side slopes are lined with rip-rap and the basin has a capacity of 63.4 million gal. at 16.5 ft. depth.

Mt. Hope, or Highland distributing reservoir at the south side of the city, was constructed at about the same time as Rush Reservoir. At a depth of 15 ft. it holds 22.5 million gal. It is built on a sand hill, puddle-lined, the lower half of the slopes rip-rapped to a 5-ft. berm and the upper half above the berm, paved.

Another distributing reservoir was constructed in 1905–8 on Cobb's Hill, with water surface at the same elevation as Highland Reservoir, namely, 125 ft. above the central portion of the city. Cobb's Hill Reservoir has a capacity of 144 million gal. at 25 ft. depth, and is lined on the bottom with concrete and surrounded by a gravity section concrete wall backed up on the outside by a heavy earthen embankment. We therefore have in all the reservoirs an available storage, at the present rate of consumption,

FIG. 1. COBB'S HILL RESERVOIR COMPLETED IN 1908.

of about one week's supply. The construction of this reservoir was described and illustrated by the speaker in a paper before this Society at its meeting here September 11, 1910.

Studies of the rate of consumption were made during the census weeks of the years 1900 and 1910. These rates plotted indicated that the use drops to a minimum of about 35 gal. per head, daily, and rises to a maximum of about 135 gal. The mean consumption for the period of the test was 84.9 gal. per head per day. We have had single day's use during very hot weather as high as 35 million gal.

Conduits.

We have at present three gravity conduits from Hemlock Lake, and the Canadice water is conducted into Hemlock Lake so that it reaches the city through the Hemlock conduits.

Conduit I was laid in 1873–4, and consists of cast-iron and wrought-iron pipe, with lead joints. For 10 miles from the lake it is 36 in. in diameter. For the next 10 miles to the storage reservoir at Rush it is 24 in. in diameter, and laid to a steeper hydraulic grade. From Rush Reservoir to the distributing reservoir in Highland Park, a distance of about 9 miles, it is 24 in. in diameter. Its capacity to Rush is 6.125 million gal. daily, and from Rush 6.75 million gal.

Conduit II was constructed in 1893–4 and follows the same general direction as Conduit I. After leaving the lake, however, it avoided the quicksand of the valley by tunneling through the high ground to the east. This section is a masonry conduit 6 ft. in diameter, 8 000 ft. constructed in tunnel and 4 000 ft. in open cut. It is built to a gradient of one in 4 000.

The intake pipe for Conduit I is about 1 000 ft. long and 36 in. in diameter. The intake for Conduit II extends 1 500 ft. into the lake, and is 5 ft. in diameter. From the lower end of the masonry section at Overflow No. 1 the pipe lines of Conduits II and III continue northerly toward the city.

Conduit II, from White Bridge to Rush, consists of 38-in. riveted steel pipe from $\frac{1}{4}$ to $\frac{3}{8}$ in. in thickness, and about $17\frac{1}{2}$ miles in length.

Overflow No. 2 is about half-way between Overflow No. 1 and Rush Reservoir, and at this point the conduit rises to hydraulic grade. The conduit between Overflows Nos. 1 and 2 crosses the Hemlock Outlet and Honeoye Creek ten times, and at these points is protected by concrete beneath the bottom of the stream.

From Rush Reservoir to a gate vault in Clinton Avenue South, near the city, the pipe is riveted steel 38 in. in diameter, except for a short distance near Rush and at the crossing of the Barge Canal where it is 36-in. cast-iron. The total length is about 8 miles.

From this gate vault, which is a junction point, Conduit II continues to Highland Reservoir, about $\frac{7}{10}$ of a mile, as a 38-in. riveted steel pipe, and a 36-in. cast-iron pipe about $1\frac{1}{2}$ miles long runs to Cobb's Hill Reservoir.

The capacity of Conduit II into Rush is 15.75 million gal. and out of Rush 18 million gal. daily. This difference is due to the fact that Rush Reservoir lies above the hydraulic grade line connecting the ends of Conduit II.

Returning to Overflow No. 1, at White Bridge, the northern end of the masonry conduit, Conduit III, constructed in 1914–18, commences as a 37-in. cast-iron pipe and extends to Factory Hollow, a distance of about 7.7 miles. From this point it continues as a 37-in. lock-bar steel pipe through Overflow No. 2, following the route of Conduit II to Rush Reservoir and thence to the gate vault above mentioned in Clinton Avenue South, a total distance of about 18 miles. Its capacity into Rush is 18.125 million gal., and out of Rush 19.5 million gal., daily. This conduit,

FIG. 2. CURVE IN 37-IN. CAST-IRON PIPE CONDUIT IN ROCK CUT.

the same as Conduit II, crosses the Barge Canal as a 36-in. cast-iron pipe, where both pipes are enclosed in an accessible masonry culvert with gate vaults and cross-connections at each end.

The combined capacity of these three conduits is 40 million gal. into, and 44.25 million gal. daily out of, Rush Reservoir, and is sufficient to carry all the waters available from the Hemlock and Canadice watersheds, with such leeway as may be necessary in case any section is out of service for repairs.

All of the conduits are laid in easements obtained by the city. The agreements in the case of Conduit I only provided for construction and operation. Damages have to be paid to owners whenever excavations are made for repairs. The Conduit II agreements were broader and covered the right to excavate, construct, operate, and maintain a pipe or pipes, conduit or conduits, under, through, and along said strip of land. The easements were three and four rods wide. Conduit II was laid 5 ft. east, and Conduit III 5 ft. west, of the center line of the right of way. Where

FIG. 3. MACHINE CALKING ON 37-IN. LOCK-BAR STEEL PIPE LAID IN 1917.

FIG. 4. CURVE IN 37-IN. LOCK-BAR STEEL PIPE LAID IN 1917.

land was worth $30 per acre, we paid about $100 per acre for the easement. It is not fenced, but we maintain fences and gates at division lines crossing the right of way between adjoining owners. Where the conduit is laid in highway, an easement is obtained from the abutting owner for his half of the road. About $1 per rod was the minimum price, when there was no damage to trees.

The construction of Conduits II and III, side by side, generally 10 ft. center to center, the former in 1893–4 and the latter 20 to 25 years later, offers an interesting comparison of the combined cost of materials and construction. The cost of right of way, engineering, etc., is excluded in both cases.

Conduit II, 138 238.57 ft. long, cost $1 226 874.71. It is mainly 38-in. riveted steel pipe.

Conduit III, 134 605.07 ft. long, cost $1 173 326.37. It consists of 7 miles of 37-in. cast-iron pipe, and the remainder 37-in. lock-bar steel pipe.

The above figures indicate that in 1893–4 the 38-in. conduit cost 23.4 cents per linear foot per inch of diameter against 23.6 cents for the 37-in. conduit in 1914–1918.

This close correspondence is mainly due to the methods employed in construction. In the early 90's materials and labor were cheap, and an army of workmen was employed; while during the late war, men were scarce, materials and labor high, and consequently the work was largely done by machine.

Two other items of the design which contributed to more economical construction of Conduit III were, first, the use of lock-bar, rather than riveted, steel pipe, which, due to a more efficient longitudinal joint, resulted in a 25 to 33⅓ per cent. reduction in thickness where the pressure was high; and, second, the construction of a 37-in. cast-iron pipe, where under light pressure, at about the same cost as a 36-in. by using a 36-in. Class D pattern with a 37-in. core, thus procuring a pipe 1.08 in. thick and weighing about 418 lbs. per foot.

The author, although not a member of this organization, has been asked to prepare this paper by Mr. Little, your General Chairman, with whom he has been associated in the city's employ since 1891, when both started on the surveys and plans for Conduit II under the late Emil Kuichling, then Chief Engineer of Water Works.

In 1902 Mr. Little became Superintendent of the Water Bureau while the author remained in the Engineering Department where, under the last three city engineers, he has designed and supervised the construction of Cobb's Hill Reservoir and Conduit III, and now has studies and surveys under way looking toward the utilization of Conesus Lake and Honeoye Lake. His early remembrance of looking into a walled excavation and being told it was a reservoir of the Rochester Water Company antedates the present water supply, and his first active entrance into the details of water-works construction consisted in crawling through the 16-in. pipes when first laid in front of his home in 1875.

DESCRIPTION OF WATER SUPPLY OF CITY OF SYRACUSE, NEW YORK.

BY MARSHALL B. PALMER.*

[*Read September 30, 1924.*]

Prior to 1888, the City of Syracuse had been supplied for about 60 years by a private water company. The water furnished by this company, it is reported, was neither palatable nor wholesome, and the works, generally, were insufficient and in rather poor condition.

A small portion of the City was supplied from Onondaga Creek, other portions coming from springs and brooks on adjoining hills. Spring water was sold by the gallon and delivered in bottles and tanks. Rain water was collected on roofs and stored in cisterns for laundry and other purposes. The plant owned by the Water Company consisted of a pumping station, three reservoirs, and about 40 miles of street mains, two thirds of which were of only 4- and 6-in. pipes. The main supply was pumped from Onondaga Creek into Wilkinson Reservoir, this supply being slightly augmented by water from various springs above Elmwood. The old Wilkinson Reservoir was only 108 ft. above the Erie Canal, so that where the City now has a pressure of about 95 pounds in the business section, the static pressure was formerly only about 40 pounds, and in case of fires the mains were so small that the pressure dwindled very seriously.

The agitation for another supply had been in progress for some 20 years, and as early as 1871 Mr. J. J. R. Croes investigated and reported on the subject of a supply from Tully Lakes, and between then and 1888 various projects were broached and companies formed for the purpose of introducing a new supply from a variety of sources.

In 1888, a Board of Special Commissioners was appointed by the Mayor to make a thorough investigation of all available sources of water supply for the City, with Mr. Croes to take charge of the investigation. A complete investigation, including topographical, chemical, and biological, was made of the following eleven sources of supply, — Lakes Ontario, Oneida, Otisco, Cazenovia, Tully, Skaneateles, the Salmon River, Seneca River, Onondaga Creek at Cardiff, ground water in the creek valley from driven wells, and the old Water Company's Works. Mr. Croes strongly recommended the water of Skaneateles Lake. This lake is 300 ft. deep in places, has an area of $12\frac{3}{4}$ sq. miles, surrounded by a steep, bold watershed of $60\frac{1}{4}$ sq. miles, free from swamps and vegetable growth. The water is remarkable for its clearness, its purity, and its beautiful blue color. It

* Engineer, Bureau of Water.

is situated at an elevation of 460 ft. above the business part of the City and 19¼ miles from the City distributing reservoir.

The rainfall at Skaneateles ranges from 32 to 48 in. per annum, and the run-off of the lake from 55 to 70 million gal. per day.

Acting on Mr. Croes' advice, the City voted in favor of a municipal water supply, to be taken from Skaneateles Lake, and a Board of Water Commissioners was appointed to take charge of the work. They engaged the late Wm. R. Hill, C.E., as Chief Engineer, and Howard Soule, C.E., as Consulting Engineer, to design and construct the necessary works. Much opposition was met from the people of Skaneateles, the mill owners along Skaneateles outlet, and the shippers on Erie Canal. All of these obstacles were met and overcome, and the works completed so that water was turned into the conduit in June, 1894; and Woodland Reservoir was finished and put in use the following year.

The following is a brief description of the plant as it exists today:

Dam at Outlet of Lake.

To meet the requirements in the law authorizing the City to take water from Skaneateles Lake, it was necessary to increase the storage capacity of the lake sufficiently to store therein the ordinary annual flow of its watershed. The storage capacity of the lake was increased by removing the old dam, which was 9 ft. high, and rebuilding another 17 ft. high, with a spillway 2 ft. higher and foundation 6 ft. lower than the old structure. The bed of the outlet was lowered to conform to the new grade made necessary by the lowering of the gates of the dam. There are six rectangular cast-iron sluices, each 3 ft. by 3 ft., 9 in. in the new dam. These gates control the flow of water down the outlet to supply the canal, and through them it is possible to draw the lake down 17 ft. below its new high-water mark.

Intake from Lake.

The intake pipe which conducts the water from the lake into the Skaneateles Gate House, and also this gate house, were originally built large enough to serve two conduits. The intake pipe is of riveted steel plates ⅜ in. thick and 54 in. in diameter, and extends out into the lake about 6 400 ft. The timber crib at the end is 16 ft. square and 12 ft. high and is located in 40 ft. of water. The water enters the top of the crib through a copper wire screen of 1-in. mesh. Flexible joints were used to allow the pipe to conform to the profile of the lake bottom. When only Conduit No. 1 is flowing, there is a loss of head of 1 ft. in the intake pipe. With both conduits flowing into Woodland Reservoir, the loss of head is about 3½ ft.

Skaneateles Gate House.

The Skaneateles Gate House is located about 200 ft. north of the lake and contains two wells. Two cast-iron sluices, each 2½ ft. x 4½ ft.,

conduct the water from the upper to the lower well, and in the latter it passes through screens of $\frac{1}{4}$ in. The outlets from the lower well into the conduits are through special reducers.

Conduits.

The topography between Skaneateles and Syracuse is rolling with valleys generally extending north and south. The lake outlet runs due north and the fall for the first 8 000 ft. is only 2 ft. The slope of the hydraulic gradient of Conduit No. 1 is .00236 so that, in order to keep the conduit below the gradient at time of low water in the lake, it had to be laid rather deep through a very wet quicksand and silt. This work on Conduit No. 1 was so expensive as to bankrupt the contractor, and it cost the City about $200 000, or $30 per ft. extra, to complete. The legislative act permitting the City to take water from Skaneateles Lake restricted the size to 30 in. on the first conduit. This was later changed so that on Conduit No. 2 a larger pipe (42 in.) was laid on a flatter grade through this bad section. After following down the lake outlet for three miles, the divides between valleys are low enough so that a generally straight line was followed from there to the City without getting above the hydraulic gradient.

Conduits 1 and 2 are both of 30-in. cast-iron pipe, except the upper 8 000 ft. of No. 2, where the size, as above mentioned is 42 in. Conduit No. 3 will be of 36-in. pipe; section one of the latter, 31 800 ft. long, has recently been laid but is not yet in service. Concrete pipe is being considered for the upper end and for a new intake where the pressure is light.

Conduits 1 and 2 are thick enough to withstand the static head obtained by closing the valves at the lower end. The lightest pipe (Class A) is $\frac{7}{8}$ in. thick and withstands a head of 130 ft. Each succeeding class is $\frac{1}{16}$ in. thicker than the preceding, and sustains an additional head of 35 ft. Class K pipe is $1\frac{1}{2}$ in. thick and sustains a head of 480 ft. Most of the breaks that have occurred were in the lighter weights of pipe, but were probably the result of small cracks caused by handling, and overlooked in laying and testing. Gate valves located in brick houses are located about two miles apart and usually on summits. Four-in. special hand-operated air valves are located on all summits on Conduits 1 and 2. On these lines considerable pains were taken to obtain a continuously ascending or descending grade between blow-offs and air valves, but on Conduit No. 3 considerable cut and fill was saved by following the surface of the ground closer and installing automatic air valves at each summit. Blow-offs are provided at each depression. The blow-off valves, which range from 6 to 12 in., are located in brick or concrete manholes.

The conduits cross two ravines, each 100 ft. deep and a third one about 50 ft. deep. Special curved pipe, embedded in concrete, was used at tops and bottoms of the slopes to form the vertical curves.

Manholes are provided about a mile apart.

Three cross-overs, connecting Conduits 1 and 2, were installed and two more are being placed. In the event of a break in the line, valves can be closed, shutting off the damaged section and the cross-overs above and below that section opened, and thus only a portion of one conduit is out of commission while repairs are being made. These cross-overs have been found a great help in keeping the reservoir full when repairs are made along the line. The conduits are laid along a leased right-of-way 60 ft. wide, No. 1 in the center and the other two 15 ft. on either side.

Thus far, Syracuse has used only cast-iron for water mains and it has been very satisfactory. The speaker recently traversed 10 000 feet of Conduit No. 2 and found the inside coating to be in fine condition. The pipe numbers and weights, painted on inside with white paint, were very legible and only two small pea-size tubercles were found.

Reservoir.

The only distributing reservoir in the City is Woodland Reservoir which has a capacity of 121 million gal., has 14 acres of water surface, is 36 ft. deep, 220 ft. above the business district, surrounded by spacious grounds attractively landscaped, and equipped with a very complete system of piping and valves for diverting the flow of the conduits either into the reservoir or standpipe or to the high or low service systems.

It is located in a shallow depression at the foot of a hill in a material reported as stiff clay and hardpan. The embankments at either end were formed from excavated material, and the cut-off walls formed of clay puddle. The bottom and sides, up to the berm 15 ft. above the bottom, are lined with concrete 9 in. thick. Above the berm the sides are lined with a 6-in. layer of concrete over which is a 12-in. rubble-stone slope wall laid in cement. After 30 years' service these walls are in splendid condition and no leaks have ever been detected.

As this reservoir holds but four to five days' supply, it is felt advisable to provide more storage at or near the city and, with this in view, surveys have been partially made at several possible sites.

Distributing System.

The City had in 1890 a population of about 89 000, with 172 miles of streets and only 40 miles of distributing mains, and those of small size. Under the direction of Mr. Hill, a new system was laid out and constructed which has been extended from year to year to keep pace with the growth of the city, so that Syracuse now has a splendid distributing system. The mains are so large and the cross-connections so numerous that the pressure remains very constant, even during the largest fires. The valves are of full size and so located as to require the closing-off of only small sections for making connections or repairs. The pressure in the business section is about 95 pounds. There are now 251 miles of mains, 3 600 hydrants,

3 560 gate valves, 30 900 metered service taps, and 310 unmetered fire services in use. The main arteries of feed from the reservoir are two 36-in. and one 30-in. main.

High Service System.

The topography of the City of Syracuse, while quite level in the business section, is partially surrounded with hills. The highlands lie on the northeast, southeast, and southwest quarters. The business section is about 404 ft. above sea level, and Syracuse University is located in the southeastern section and is surrounded by a large residential section, a large portion of which is too high to be served by the reservoir.

In 1909, when the second conduit was laid, it was first planned to build a high-service reservoir on Onondaga Hill, 125 ft. above the above-mentioned Woodland Reservoir. The excavation would be largely in rock, and the cost of the reservoir, the two miles of mains thereto, the land, upkeep, and watchmen, evaporation, etc., would be so much more than for a standpipe close to the reservoir that the latter was chosen and built at a cost of $42 000. It is of steel, encased in a rock-faced vitrified brick tower, trimmed with massive precast stone locally known as litholite, and surmounted with a steel-and-concrete dome. The tank is 66 ft. in diameter and 51 ft. high; the top is 108 ft. above the reservoir and holds $1\frac{1}{4}$ million gal. Under normal conditions, Conduit No. 2 flows into the high-service system and such part as is not used overflows from the standpipe into the reservoir. At times of shortage of water both conduits are turned into the reservoir and an 8-in. centrifugal pump is used to pump from low to high service.

General.

In determining the size of the 3d conduit, it was decided that 50 to 52 m.g.d. would be all the City would be allowed to draw from the lake. While the City has acquired all power rights along Skaneateles Outlet, at a very high cost. it is doubtful whether the State Board of Health will allow the city to take any more of the run-off, the total, as above stated, being from 55 to 70 m.g.d.

There are many cottages on the lake. The shores are patrolled by sanitary inspectors, and a boat crew visits all cottages weekly in summer and collects the refuse from the toilets in pails, and carries it a safe distance from the lake and buries it.

Samples of water are collected along the shore at the mouths of streams and tested.

An up-do-date chlorinating machine is operated continuously at the Skaneateles Gate House, using about 42 pounds of chlorine daily at present. Self-registering pitometers are used to measure the flow at each end of Conduits 1 and 2, also of the city consumption in both high and low-service systems. The City now has a population of about 185 000 and adjoining suburbs of 20 000 and an area of 19 sq. miles.

The present daily consumption is about 26 million gallons which seems large but is partly accounted for by the fact that the railroads and several manufacturers are very large consumers. A water waste survey is being carried on and many leaks have been located and repaired. The construction of new conduits is in charge of the City Engineer. All maintenance and extension work is done by the Bureau under the direction of the superintendent. A contract has just been awarded for a second steel standpipe 77 ft. in diameter by 60 ft. high, to provide additional storage for high service and will be located in Thornden Park in the university section.

Thomas H. Mather is City Engineer, P. Frank Durkin, Superintendent. and the speaker, Engineer, Bureau of Water.

INCREASE OF AVAILABLE WATER SUPPLY WITH NO CAPITAL INVESTMENT.

BY FREDERIC E. BECK.*

[*Read October 3, 1924, by Charles W. Sherman.*]

The title of this paper might lead one to believe that the days of miracles were not of the past, but I hope that by the time I have finished I shall have proven that the title is not a misnomer and that it is possible in a great many cases to increase the amount of water available for use, and for sale, without the necessity of new capital investment.

In 1917 the Consolidated Water Company of Utica, N. Y., was face to face with the problem of increasing the amount of water available for use in the city and surrounding territory. The population was increasing rapidly, owing to the location in Utica of large manufacturing plants which were engaged in the manufacture of war materials. The demand for water from the textile manufacturers alone was increasing so rapidly that it was imperative that steps be taken at once to increase the available water supply.

The main source of supply of the Water Company is the West Canada Creek, and the water is taken from the creek through the Hinckley Dam, a State Barge Canal storage reservoir, located about twenty-one miles from Utica. The water is transmitted by gravity a distance of about twelve miles through a cast-iron pipe of 24-in. diameter to a standpipe located on the hills northerly of Utica. At the standpipe the water is divided and is transmitted through two separate pipe lines to distributing reservoirs located on the hills surrounding the city.

Plenty of water was available at the source, and the problem was simply to select the best and quickest method of providing an increase in the carrying capacity of the transmission main.

The engineers engaged to study the problem submitted a report showing the construction necessary to obtain the required amount of water, together with estimates of construction and operating costs.

An alternate plan, which called for booster pumps to increase the head on the present 24-in. pipe line, was also considered, but was discarded in favor of the construction program which called for the construction of certain sections of the new transmission line each year. The construction was to begin at the dam, and as each section was completed it was to be connected with the present pipe line. In this way the required carrying capacity would be obtained with the minimum amount of construction each year.

* Chief Engineer, Consolidated Water Co. of Utica, N. Y.

The estimated future supply required, together with the amount of water available after construction, was as follows:

Year.	Consumption M.G.D.	Consumption M.G.D. 20% Excess.	Construction.	Estimated Cost.	Available Capacity after Construction.
1918	12	14.4	12 000 ft. 42 in. pipe	$375 000	14.8
1919	12.5	15.	13 300 ft. 24 in. pipe	167 000	14.8
1920	12.9	15.5	11 500 ft. 24 in. pipe	141 000	14.8
1921	13.2	15.9	9 500 ft. 36 in. pipe	197 000	16.0
1922	13.6	16.3	None		16.
1923	13.9	16.7	11 500 ft. 30 in. pipe	219 000	16.
				$1 099 000	

After this date the construction of the new pipe line was to proceed at the rate required to meet the demands for increased supply.

In the schedule just given the 24 800 ft. of 24-in. pipe was designed to parallel a line of 16-in. pipe in order to deliver a larger amount of water from the standpipe, before mentioned, to one of the distributing reservoirs, and the 11 500 ft. of 30-in. pipe was to form a new connection between this reservoir and the distribution system.

It will be seen that the construction program necessary to produce the required amount of water to meet the demands of this six-year period would require a capital expenditure of $1 099 000.

The interest charges on this investment, based on a rate of 7 per cent. and not compounded, would amount during this period to $289 895.

That was a large investment for our company to make at this time, and there was a question as to whether or not it would be possible to obtain the necessary materials and labor to complete the work in time to meet our requirements.

The foregoing has been related simply to give you an idea of our problem and the method by which it was planned to meet that problem. We are in no way different from the majority of water companies and have no desire to spend large sums of money on construction work before it is actually needed, and therefore we gave the matter more careful study than is done in a majority of cases.

During the time our engineers were preparing their report, it was decided to have a pitometer or waste-water survey made in a typical section of the city in order that we might obtain a better check on our consumption records, and to determine if it would be possible to eliminate enough leakage from our system to bring the daily consumption within the limits of our supply.

For this purpose the services of a company specializing in this class of work were engaged, and the survey was completed and the report submitted at about the same time as that of our engineers.

This report showed that a considerable amount of water was flowing into the section under observation, and that it was not being recorded by the meters, and must therefore be considered as water unaccounted for. It was decided that if this section were typical of our entire system, and that if the water unaccounted for could be located and the leaks repaired, enough water would be reclaimed so that our construction program might be delayed for one or two years.

After the consulting engineers engaged by the Company had studied the report on the waste-water survey, it was decided to postpone new construction and to bend every effort to locate and repair all leaks in our distribution system.

A force of engineers and inspectors was organized under the supervision of a man experienced in this line of work and a thorough survey was made of the entire distribution system. As most of you are undoubtedly familiar with the methods and instruments used in the detection of underground leakage, I will not go into any of the details of this work further than to say that the results obtained far exceeded our expectations. At the end of the summer of 1919 we had located and repaired leaks amounting to a total of 1.7 million gal. of water per day. Not one of these leaks could be located from the surface of the ground, as the water was in most cases finding its way into the sewers.

The survey was continued during 1920 and again the entire system was covered, with an additional saving of 800 000 gal. of water per day. We have made this work one of the features of our engineering department and each year we check up our system and see that the water unaccounted for does not exceed that allowed in good engineering practice. We are now accounting for 86 per cent. of our supply.

I might say at this point that our system is fully metered and that all of our supply mains are equipped with Venturi meters.

The following is a comparison of the daily consumption as estimated in 1917, — the actual consumption after the waste survey and the available supply as furnished by the original 24-in. transmission main:

Year.	Estimated Consumption M.G.D.	Actual Consumption M.G.D.	Supply M.G.D.
1918	12.2	12.2	12.4
1919	12.5	10.8	12.5
1920	12.9	11.5	12.0
1921	13.2	10.7	11.5
1922	13.6	10.7	10.8
1923	13.9	11.0	10.6 - 8 months

A comparison of the figures just given shows some very interesting facts. It will be seen that if we add to the actual consumption figures the

amount of reclaimed water, amounting to 2½ million gal. per day, the total would be practically identical with that of the estimated amount required.

The fact is also clearly shown, that the available supply would not have equalled the demand during the year 1919, the supply-and-demand figures being equal with no water in reserve.

Another interesting feature is the fact that the available supply is constantly decreasing, and that in a period of six years the carrying capacity of our transmission main had decreased by 1.8 million gal. per day, or a decrease of nearly 15 per cent.

It was further shown that, notwithstanding the large saving of water lost through leakage, we would have been obliged to increase our supply during the year 1922. Knowing that it would be impossible to further reduce our consumption, the only answer was to increase the carrying capacity of our transmission main.

Having learned by this time the meaning of the title of this paper, "Increase of Available Water Supply with No Capital Investment," we were of course loath to start our construction program with the accompanying large investment of money and increased operating charges.

I have already called attention to the decreased carrying capacity of our transmission main.

A study of this main, together with pressure surveys and investigations of the interior condition of the pipe, disclosed the following:

There were apparently no large obstructions located in the pipe, the valves were all in good condition, and the pipe was not badly tuberculated. The inside of the pipe did, however, have a very thin coating of a slimy material which was not apparent to the eye when the pipe was dry, but which could be felt with the fingers on a wet pipe.

The value of "C" in the Hazen & Williams' formula having been determined by means of the pitometer to be but 90, it was determined to clean this pipe line and, if possible, postpone still further the construction of the new pipe line.

In October, 1922, the main was cleaned by the National Water Main Cleaning Company of New York, and measurements made one month after the cleaning showed that the value of "C" in the Hazen & Williams' formula had been increased from 90 to 131, and that we had temporarily, at least, increased our available supply of water by 3.8 million gal. per day — this again without the investment of capital.

At the end of 1923 the relation of our available supply to the consumption after the water-waste survey and the cleaning of the transmission main was practically the same as it would have been had we proceeded with the construction program as considered in 1918.

The following comparisons of cost are interesting:

Year.	Construction Program. Cost of Construction.	Yearly Carrying Charge at 7%.	Pitometer and Cleaning Program. Operating Costs
1918	$375 000	¾ of yr. $19 687	$103
1919	167 000	35 017	4474
1920	141 000	45 342	2 015
1921	197 000	58 152	566
1922	None	61 600	9 464
1923	219 000	73 097	
	$1 099 000	$292 895	$16 622

In this comparison of operating costs, interest has been taken at the rate of 7 per cent., with no allowance for depreciation or operation of the proposed new pipe lines. It has been assumed that during the year of construction the interest time would be nine months.

The comparison of costs show, under the construction program, a total expenditure of $292 895 for interest alone, as against a total operating charge of $16 622 under the waste survey, plus cleaning program; or a saving of $279 233 for the six-year period.

At this date, September, 1924, we feel that we have exhausted all means for the "Increase of Available Water Supply with No Capital Investment," and are now making plans to begin the construction program as outlined during the coming year.

This paper is not written with the thought that all water companies can postpone construction in the manner outlined, but I do feel that in a great many cases, if experts in water-waste surveys or the cleaning of water pipes would be consulted, that the construction of new work could be delayed, and a large investment in capital, with the accompanying increase in operating charges, saved for several years.

RELATION OF IMPROVEMENTS IN WATER SUPPLIES TO TYPHOID FEVER AND OTHER INTESTINAL DISEASES.

BY C. A. HOLMQUIST.*

[*Read October 1, 1924.*]

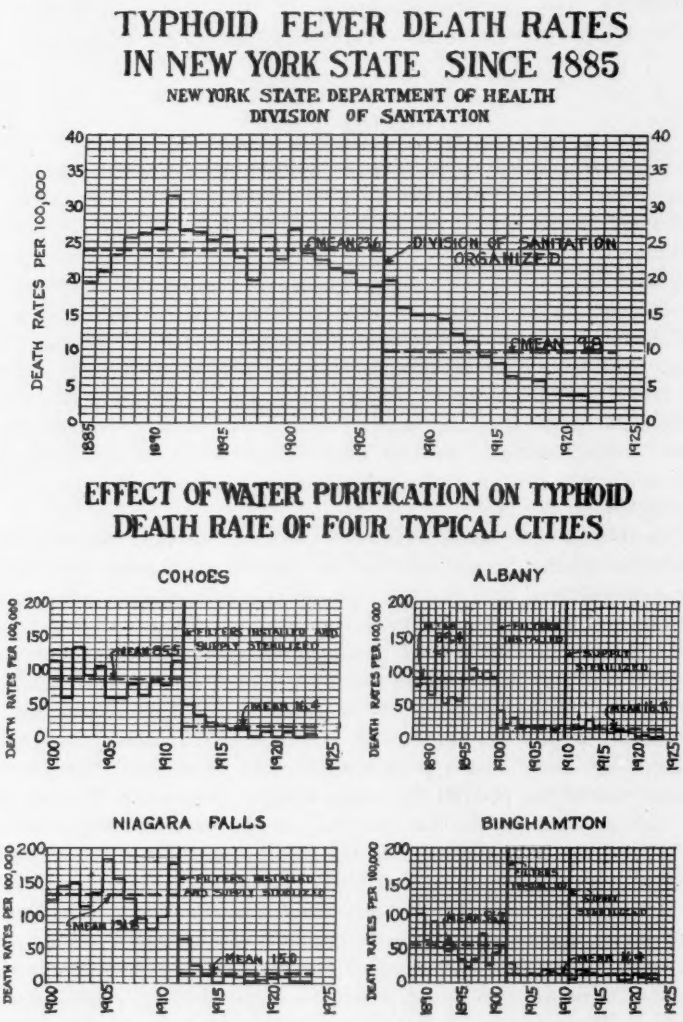
That typhoid fever and certain other intestinal diseases are often water-borne, is too well known to need discussion, especially before an association of this kind. We all know of the large number of typhoid outbreaks that have resulted recently from cross connections between polluted auxiliary fire and industrial supplies and domestic municipal supplies, and from temporary failures or interruptions in the operation of water purification and treatment plants handling raw waters polluted with sewage. It may be worth while, however, to call attention to the remarkable reduction that has taken place in the typhoid fever death rate in this country and, particularly, in the State of New York, during the past twenty years. I shall endeavor to show that this reduction has been coincident with and largely the result of developments, extensions, and improvements in public water supplies.

In 1900 the average typhoid fever death rate in the then registration area in the United States was 31.3 per 100 000 population. During the 5-year period from 1918 to 1922, inclusive, the rate in this same area was only 5.3, a reduction of 83 per cent. Practically the same conditions have been experienced in New York State. From the accompanying diagram it will be seen that in 1900 the typhoid fever death rate in New York State was 26.7, and that during the 5-year period ending 1923 it was only 3.3, a reduction of 87.6 per cent. This is very significant when we consider that in New York, with a population of over 10 million, a drop in the typhoid rate of one per 100 000 means a saving of over 100 lives per year.

Let us now see what has happened in the water supply and waterworks field in the meantime. In the first place, the number of persons supplied with purified or treated water has increased enormously during the past twenty years. This has been due in a large measure to the development of the application of chlorine to public water supplies. Whether we consider chlorination as a method of purification in itself, or simply as an auxiliary safeguard or finishing process, is, in my opinion, of minor consideration. The important fact is that millions of people are now supplied with chlorinated and relatively safe water who would otherwise be drinking raw water or improperly purified water of questionable sanitary quality. Secondly, the art of water purification has advanced, notably in the development and perfection of mechanical filtration. These two factors

*Director, Division of Sanitation, New York State Department of Health.

have been instrumental in raising the standard of purity of water. Last but not least, health authorities, water-works officials, and the general public have learned that polluted drinking water means a high typhoid



fever death rate, and most of the States in the Union have passed water supply, sewerage, and anti-pollution laws.

Although the so-called anti-pollution law, which in general prohibits the discharge of sewage and industrial wastes into any of the waters of New York State without a written permit from the Sate Commissioner of Health,

was passed in 1903, it was not until 1906 that the Engineering Division of the New York State Department of Health was established, and systematic supervision and control of sanitary quality of public water supplies was assumed.

In 1906 only about 700 000 persons, or less than 10% of population of this State, were served with purified water. Now nearly eight million persons, equal to about 73% of the entire population of New York State, are using purified or treated water. This represents an increase in the number of persons served with treated or purified public water supplies of over 1 000% since 1906. In 1906 there were only some 18 filter plants, mostly of the pressure mechanical type, in operation. It will be seen from the following table that in 1922 there were 176 water purification and treatment plants serving 261 municipalities in New York. Nearly 70% of the surface water supplies, serving about 80% of the municipalities in this State, are treated. Furthermore, during the same period the number of persons served with public water supplies in New York has increased from about 6 million to 9 182 000, equal to an increase of 53%, whereas the population in the State has increased only about 27% in that time, or from 8 405 000 to 10 651 000.

The results of improvements in public water supplies have been clearly reflected in the typhoid fever death rate in this State. The average rate for the 22-year period from 1885 to 1906 was 23.6. Since 1906, there has been a gradual and fairly uniform drop in the typhoid rate until 1923 when it was only 2.9 per 100 000 population. That this remarkable progress has been due in a large measure to improvements in public water supplies is shown by the result of the installation of filtration and chlorination plants in such cities as Niagara Falls, Albany, Binghamton, and Cohoes. In each case, as indicated by the diagram, there was a decided and pronounced drop in the typhoid rate immediately after the installation of water purification plants, and the more grossly polluted the source of water supply, the more pronounced was the drop.

The water supply of Niagara Falls, which is a city with a population of about sixty thousand, is derived from the Niagara River about twenty-five miles below the city of Buffalo and about ten miles below the cities of Tonawanda and North Tonawanda. The sewage from these cities, having a combined population of over 500 000, is discharged without treatment into the river. Until 1912 the grossly polluted river water was used partly raw and partly inefficiently treated, and it is not surprising that Niagara Falls had the highest typhoid fever death rate of any city in the State. In 1911 two water purification works, each consisting of gravity mechanical filters and chlorination plants, were installed, one by the city and the other by the Western New York Water Company. Before these works were installed and put in operation the typhoid fever death rate in that city ranged from 80 to 184, with an average rate of 131.8. The first year that the purification works were in operation the rate dropped from 179.1 to

SUMMARY OF WATER SUPPLY DATA OF NEW YORK STATE, 1922.

1. Classification as to Source.

Character of Source of Water Supplies.	Number of Supplies.	Number of Communities Served.	Population Served.
Surface water (*a*)	249	330	7 823 000
Ground water	215	270	1 066 000
Supplies derived partly from surface and partly from ground water sources (*b*)	89	91	293 000
Total (*c*)	553	691	9 182 000

2. Classification as to Treatment.

Character of Treatment of Water Supplies.	Number of Supplies.	Number of Communities Served.	Population Served.
Treatment by chlorination only (*d*)	79	123	6 726 000
Mechanical filtration and chlorination	48	83	657 000
Slow sand filtration and chlorination	12	15	325 000
Mechanical filtration without chlorination (*e*)	20	22	44 900
Slow sand filtration without chlorination (*f*)	17	18	43 300
Total (*g*)	176	261	7 796 200

(*a*) Of the 249 surface water supplies in the State, 98 are protected from contamination by rules and regulations enacted by the State Department of Health.

(*b*) Although the New York City supply is derived partly from wells, it is listed under surface supplies, inasmuch as only a very small percentage of the total supply is from wells.

(*c*) Of the 553 supplies in the State, 336 are owned and operated by municipalities; 192 are owned and operated by water companies serving one community each and 25 are owned and operated by water companies serving two or more communities each.

(*d*) Include both liquid chlorine and hypochlorite of lime plants.

(*e*) Of the 68 mechanical or rapid sand filters, 34 are of the gravity type and 34 of the pressure type, and one supply has both a gravity and mechanical filtration plant.

(*f*) A few water supplies are provided with both slow sand and mechanical filters operated either in series or independently. In such cases they are counted under the type of filter predominating.

(*g*) Eighty-six per cent. of population in State served by public water supplies, 73% by treated water.

Note: The estimated population of the State in 1922, based upon the average annual increase between the United States censuses of 1910 and 1920, was about 10 651 000.

65.2 and the next year to 26.6. During the past six years the rate has been only 5.0, a reduction of about ninety-six per cent. This remarkable reduction must be attributed very largely to the purification of the water supply; in fact, it could hardly be accounted for in any other way. Incidentally, it might be noted that these works have been a paying investment to the city, not only from a public health but also from an economic standpoint, considering the fact that a death rate of 131.8 in Niagara Falls means 79

deaths a year from typhoid and probably ten times as many cases of illness from this disease. Assuming that a life is worth $5,000, there would have been an economic loss of some $400 000 a year if that rate had continued.

The city of Cohoes, of about twenty-three thousand population, obtains its water supply from the Mohawk River, some 18 miles below the city of Schenectady. The sewage of Schenectady, which city has a population of about ninety thousand, was discharged into the Mohawk River without treatment until 1915. This river also receives the raw sewage from the cities of Amsterdam, Utica, and part of Rome, and from a number of smaller municipalities. In 1911 the city of Cohoes installed gravity mechanical filters and a chlorination plant. The typhoid fever death rate of Cohoes prior to the installation of these works varied from a minimum of 57.8 to a maximum of 133.2, with an average of 85.5. The average rate for the past six years has been 3.7 per 100 000 population.

The city of Albany, which has a population of nearly one hundred twenty thousand, derives its water supply from the Hudson River at a point about eight miles below the mouth of the Mohawk River and from 4 to 10 miles below the cities of Troy, Cohoes and Watervliet. These cities which have a combined population of over one hundred thousand, discharge their sewage into the Hudson River without any treatment. In fact, the sewage from a population of nearly five hundred thousand is discharged into the Hudson and Mohawk rivers and their tributaries above the Albany intake. In 1899 slow sand filters were installed, and in 1908 preliminary or scrubbing filters of the gravity mechanical type were completed and put in operation. In 1909 chlorination of the supply with hypochlorite of lime was commenced and in 1916 this treatment was supplanted by liquid chlorine. Before the slow sand filters were installed the typhoid fever death rate of Albany varied from 52.8 to about 171.4, with an average of 89.4 per 100 000 per year. The first year after the installation of slow sand filters the typhoid fever death rate of Albany was reduced from 87 to 40. During the past five years the average death rate from typhoid has been 4.1. The rise in the rate noted on the diagram in 1913 was due to the flooding of the filtration plant owing to extraordinary high water in the Hudson River. For two days raw Hudson River water was pumped into the system and this was followed by some 180 cases of typhoid and over 20 deaths.

The city of Binghamton, with a population of about seventy-five thousand, derives its water supply from the Susquehanna River above its junction with the Chenango River. Although this stream receives comparatively little raw sewage within 75 miles of the intake, the river has a drainage area of some 2 400 square miles at this point and flows through a fairly thickly developed rural district. Gravity mechanical filters were installed in 1901 and chlorination of the supply was commenced in 1910. The typhoid fever death rate at Binghamton before the filtration plant was installed varied from about 25.5 to 101, with an average rate of 56.2 per

100 000 population. The average death rate from typhoid during the past six years in this city has been 4.0.

A large number of other cases, almost as striking, could be cited, but it seems that the above figures indicate the remarkable effect of water purification on the reduction of the typhoid fever death rate in New York State. I do not, however, wish to give the impression that extensions and improvements in public water supplies have been entirely responsible for this reduction. Other factors, such as milk pasteurization, improvements and extensions of sewerage facilities, and the consequent elimination of insanitary privies, campaigns against the fly, and more efficient public health work and public health education, — have all been important allies in the fight against typhoid. In fact, in many localities these factors must be depended upon largely in the further reduction of typhoid, especially in certain substandard areas and those having inadequate health organizations. In such places we often find municipalities which have very good water supplies but high typhoid rates.

In New York and certain other States having low typhoid rates and generally satisfactory water supplies, it will not be possible to materially reduce these present rates through improvements in water supplies and the installation of water purification plants. Owing, however, to the fact that many of the purified supplies are derived from more or less polluted sources, it will be necessary for not only health authorities but also for water-works officials and operators to make every effort to see that the purification plants treating such waters are at all times operated with the greatest care and efficiency if we are to avoid outbreaks of intestinal diseases.

Discussion.

Mr. Henry A. Symonds.* There is one question which occurs to me in looking at these charts. I notice that the death rate from typhoid drops quite suddenly after the installation of the filters, but in practically every case, markedly the case of Cohoes, it goes down like a flight of stairs; and I am wondering just what the causes are. Is it because the filters are not as effective at first as they are after longer operation, or why is it that in the usual case, two, three, or four years are usually required to get down to the low rate?

Mr. Holmquist. I do not believe that it is because filters are not as effective when first installed as they are later that we fail to get the full benefit from filtration immediately after the filters are put in operation. In the case of a water-borne epidemic of typhoid there is almost invariably a comparatively large number of so-called secondary or contact cases which continue to occur, sometimes for a considerable period after the first infection. In my opinion, the same is true in a municipality that has a

*Consulting Engineer, Boston Mass.

grossly polluted water supply and a consequently high typhoid rate when it installs a filtration plant. A large number of cases due to polluted water gives rise to secondary cases which continue to occur for a considerable period after the installation of the water purification plant. As time goes on, the number of carriers are also reduced and the chances of contact infection become less and less, so that the typhoid rate continues to drop for some years after the purification of the water supply is commenced.

PRESENT METHODS OF WATER PURIFICATION IN PROVIDENCE, RHODE ISLAND.

BY J. W. BUGBEE.*

[*Read October 1, 1924, by Frank E. Winsor.*]

Original Supply.

City water was introduced into Providence more than fifty years ago, and ever since that time the supply has been taken from the Pawtuxet River at Pettaconset, about two miles above the point where the river discharges into Narragansett Bay.

When this location was selected, the water was not seriously polluted, but twenty-five years later, owing to the increase of population on the watershed, which has an area of approximately two hundred square miles, the pollution had become so great as to necessitate the employment of some method of purification.

Adoption of Filtration.

After a long study of the relative merits of slow sand and mechanical filters, the former were adopted, and contracts were let in May, 1902, for six open beds of one acre each. Later, four more beds were added, and all of the beds were provided with covers, as the experience of the first winter's operation of the open beds had demonstrated that satisfactory results could not be obtained from them in severe weather.

While the construction of this plant apparently insured the quality of the water delivered to consumers, apprehension had always been felt regarding the quantity which could be reckoned on in periods of dry weather, since the city had no system of reservoirs above the intake to the filters, and had always depended upon the mills situated above Pettaconset to let down a sufficient supply of water for the daily needs of the city.

Scituate Supply.

Because of this fact, studies of the possibility of obtaining a larger and more dependable supply were begun soon after the completion of the filters, and these studies resulted in the development of the Scituate project which, when completed, will replace the present filters, pumping station, and storage reservoirs. The details of this project were described by Chief Engineer Frank E. Winsor of the Providence Water Supply Board in a paper read before this Association at the convention in New Bedford in September, 1922.

It was expected that water from this source would be available in 1922, but, when it became apparent that because of war conditions the comple-

* City Chemist, Providence, R. I.

tion of this work would be considerably delayed, steps were taken to increase the capacity of the present plant.

Changes in Filter Sand.

The operation of the filters had always been handicapped by excessively high initial loss of head. In severe weather this had frequently been as high as one and one-half feet, and as the beds cannot be operated with a loss greater than four and one-half feet, the runs during the winter were necessarily very short, entailing a large amount of scraping and sand removal, and increasing the out-of-service periods of the beds.

Tests made with a series of pipes extending to different depths in the sand showed a gradual increase in loss of head from top to bottom of the bed, indicating the presence of fine material through the entire body of sand. This was due to the fact that when the beds were being constructed a sand specification was used which fixed the effective size between 0.26 and 0.34 millimeter, and in the interest of bacterial efficiency the finer limit was followed very closely. It was possible, therefore, to rewash the sand and permit the escape with the wash-water of sufficient fine material to bring the effective size up to the coarser limit of the specification.

This work of washing and replacement was begun in the summer of 1917, and eight of the beds were treated in this way during the next two seasons, exception being made in the case of Beds 1 and 2, in which beds the loss of head tests had shown only a very slight increase from top to bottom of the bed. These two beds had also shown by actual test that they were capable of maintaining rates as high as four million gallons per acre per day for a considerable length of time.

In order to carry on this work economically a system of water and sand piping was installed in the beds, and a steam-turbine-driven centrifugal pump was introduced into the main supply line leading from Sockanosset reservoir to the beds. This increased the working pressure to one hundred and ten pounds when operating three ejector-boxes and two washers.

To speed up the work still more, a large portable washer was constructed which could handle the output of two ejector-boxes, and this has proved so satisfactory that it has entirely superseded the stationary court washers formerly used.

As a result of this work the initial loss of head has been reduced to less than one-half foot, except in the very coldest weather, and the length of filter runs has been correspondingly increased without any apparent loss in efficiency.

Chlorination.

The same aversion to the use of chemicals in water treatment which had been used as an argument against mechanical filters had also been felt toward chlorination, but as the operation of the filtration plant would necessarily be disturbed during the installation of the new piping system,

and the extraordinary sand-washing operations, a chlorinator was installed as a precaution against the accidental passage of poorly treated water. This was looked upon as a temporary expedient, to be dispensed with when the plant should have resumed normal operation, but the changes extended over so long a period that chlorination came to be considered an essential feature of the treatment, and has been carried on continuously since the installation of the apparatus.

For some time chlorine was applied at a fixed rate of two pounds per million gallons, but later the excess-chlorine method of control was adopted, and the amount applied is so regulated as to leave an excess of 0.1 to 0.2 part per million after fifteen minutes contact period. The total amount required to be added to the filtered water, to maintain this excess, varies between 0.4 and 1.0 part per million.

After chlorination, which takes place just before the filtered water reaches the pumps, the water is lifted to Sockanosset reservoir, passing through the reservoir before entering the mains, and no excess chlorine has been detected at any time at the outlet end of the reservoir, but occasional complaints of taste and odor have been received at such times as the amount applied has exceeded 0.7 part per million.

The chlorination apparatus in use at present consists of two Wallace and Tiernan MDA type panels with injectors, each apparatus having a capacity of two hundred pounds per day.

A noticeable feature of the action of the chlorine has been the difficulty experienced in effecting complete removal of lactose-fermenting organisms. For example, with a treatment of 0.7 part per million, one would expect very few positive tests in ten cubic centimeters, whereas in the first six months of the present year the chlorinated water gave seventy-nine positive presumptives out of a total of one hundred and fifty-four tests made. Confirmation of these tests, however, showed that of the seventy-nine positive presumptives forty were due to the presence of a lactose-splitting anaerobe, while twenty-eight were members of the colon-aerogenes group other than true *B. coli*, leaving only eleven positive tests due to *B. coli* of fecal origin.

Lime Treatment.

One of the most important features of the present treatment is the neutralization of free carbonic acid by the addition of hydrated lime. The decision to introduce the lime treatment was brought about by the publication in the *Journal of the Rhode Island Medical Society* for January, 1918, of an article by a prominent physician of Providence on the general subject of lead poisoning. In this article it was suggested that many cases of disease of obscure cause might be attributed to lead poisoning, and that this poisoning might be traced to the city water supply, especially in a city like Providence, where lead is used for service pipes and for house plumbing.

Very few cases of lead poisoning had been reported in Providence, and

none of these had been proven to be caused by the city water, but as the character of the filtered water indicated that it might be corrosive to lead, an investigation was decided upon, and a large number of tests were made of water from all parts of the city. These showed lead in amounts varying from 0.05 to 0.80 part per million, with an average amount of 0.29 part per million; and while this did not indicate a dangerous condition, judged by the quite generally accepted limit of 0.5 part per million, it was thought advisable to remove any possible danger by decreasing the corrosive action of the water.

The carbonic-acid content of the water after leaving the filters varies at different seasons of the year between eight and fifteen parts, and it was therefore possible to neutralize all, or nearly all, of the free carbonic acid with lime without increasing the hardness sufficiently to render the water unsuitable for domestic or industrial use.

The lime is applied in the form of hydrate by means of a Gauntt dry feeder, driven by a water motor, the waste water from the motor serving to carry the lime into the filtered water conduit leading from the south regulator house. This permits a contact period of about ten minutes, which apparently is sufficient for the completion of the reaction, before the water reaches the basin at the pumping station.

The fluctuations in the amount of free carbonic acid are not rapid, and it is possible to regulate the operation of the lime treatment by daily tests, so that the free carbonic acid remaining in the water after the treatment is always between 1.0 and 3.0 parts per million. Tests for lead are made frequently in samples collected from various sections of the city, and these show that the result of the lime treatment has been an almost complete prevention of corrosive action on lead piping. Of the samples taken during the past year the greatest amount of lead found was 0.13 part per million, while the average was only 0.05 part per million, as contrasted with a maximum of 0.80 and an average of 0.29 found before the introduction of the lime treatment.

Microörganisms.

For many years the consumers using the water from Hope and Fruit Hill reservoirs had been troubled by taste and odor at certain seasons, but as the trouble had never been severe nor of long duration, nothing had been done to relieve this condition until 1918. In this year the complaints were so numerous that both reservoirs were treated with copper sulphate, which treatment resulted in stopping all complaints immediately. The cause of the trouble having been identified as uroglena, the practice has since been followed of dosing with copper sulphate whenever the weekly microscopic examination shows that uroglena is present, even in very small numbers. This has required only two treatments per season at the most, and in several cases a single treatment has sufficed for the entire season.

Conclusion.

To sum up briefly, the present treatment consists of filtration at the rate of 2.5 million gallons per acre per day, the addition of hydrated lime in amounts varying between fifty and one hundred pounds per million gallons, chlorination, using between three and eight pounds per million gallons, and copper sulphate dosing for the reservoirs whenever required.

The noteworthy fact connected with these innovations, which have supplemented the work of the sand filters, is the gradual change in the attitude of the public in relation to the use of chemicals in water treatment. The aversion which was formerly manifest apparently does not exist at present, and this is further shown by the fact that the new Scituate supply is to be filtered through rapid sand filters, with alum, lime, and chlorine as probable features of the treatment.

Discussion.

Mr. H. C. Kerr.* Mr. Bugbee states that the amount of chlorine is three to eight pounds per million gal. Is that sufficient to take care of your water all the time?

Mr. Winsor. I do not know as I can answer that as well as Mr. Bugbee, but I understand it is. The raw water which goes to this plant is at times quite bad. Above this plant there are, within a radius of eight miles, 18 fairly large mills and a population of over 35 000 people, and the water comes direct from the mill wastes and also from the domestic wastes, there being no sewerage systems in the valley. The filters, however, effect a very good result with the chlorination, and I do not think there is any question but what the chlorination has been sufficient.

It might be rather interesting to remember that Providence, from 1871 to about 1905, used this water without any purification whatever, and the only sedimentation that they had was in the reservoirs to which it was pumped. It was pumped first into a 55 million gal. reservoir, and I presume about 1905 there might have been between three and four days' storage. From that reservoir they supplied a great part of the city, fully 80 per cent. So far as I know — I have no typhoid rates in mind — they never had any real epidemics. I am under the impression that the typhoid rate itself was not particularly high. Now, I have had a sort of a theory since I have been there — the theory may not have any virtue — that the low typhoid rate might be due in no small degree to the fact that a manufacturing plant immediately above these filters has, for many years, used a large amount of chlorine in its bleachery. It seemed to me that that might be a very strong factor in the production of the figures before the filters were put in.

Mr. E. T. Cranch. I believe you mentioned the CO_2 content at

* Superintendent, Seymour Water Co., Seymour, Conn.

the beginning. I do not remember that you said what it was after you treated it with the hydrated lime. What was the reduction?

MR. WINSOR. I think Mr. Bugbee has been operating the plant so as to keep his CO_2 down to 3, and it runs from 1 to 3.

It would of course be possible to completely neutralize the free carbonic acid, but as surface waters very seldom contain less than 2 parts per million, complete removal was considered to be unnecessary.

MR. CRANCH. There is one other question I would like to ask. In applying the hydrated lime, how long a period of settlement does it have before it goes into the mains; and do you have any trouble at all with lime deposited in the meter?

MR. WINSOR. Not at all. The hydrated lime is applied at the filter plant. From the filter plant the water runs through a main, perhaps a quarter of a mile long, to the pumping station and is pumped from that station through a force main about 3 600 ft. long into a reservoir which holds about two days' supply at the present consumption.

MR. CRANCH. In our case we took the water for the chlorinators directly from the wells and we plugged the chlorinators up with the lime.

MR. WINSOR. The chlorinators are some distance away from the point of the introduction of the lime and we do not have any trouble.

I will say that I am not in any way connected with this plant; and while I have an interest in it and know something about it, I cannot give you as accurate figures as Mr. Bugbee could if he were here.

THE ESTABLISHMENT OF A METROPOLITAN DISTRICT IN BALTIMORE COUNTY CONTIGUOUS TO BALTIMORE CITY, MARYLAND.

BY V. BERNARD SIEMS.*

[*Read October 1, 1924.*]

New England possesses, in the Metropolitan Commission of Massachusetts, an excellent example of the benefits that can be obtained for the suburban districts through the consolidation of the control of water and sewerage utilities. From the standpoint of water supply, the establishment of Metropolitan Districts insures the development of resources to the best advantage, adequate service, and the control of operations by professional engineers who are not limited in working for the interest of the consumers by the necessity of showing profit; as is the case in the privately owned and operated water works.

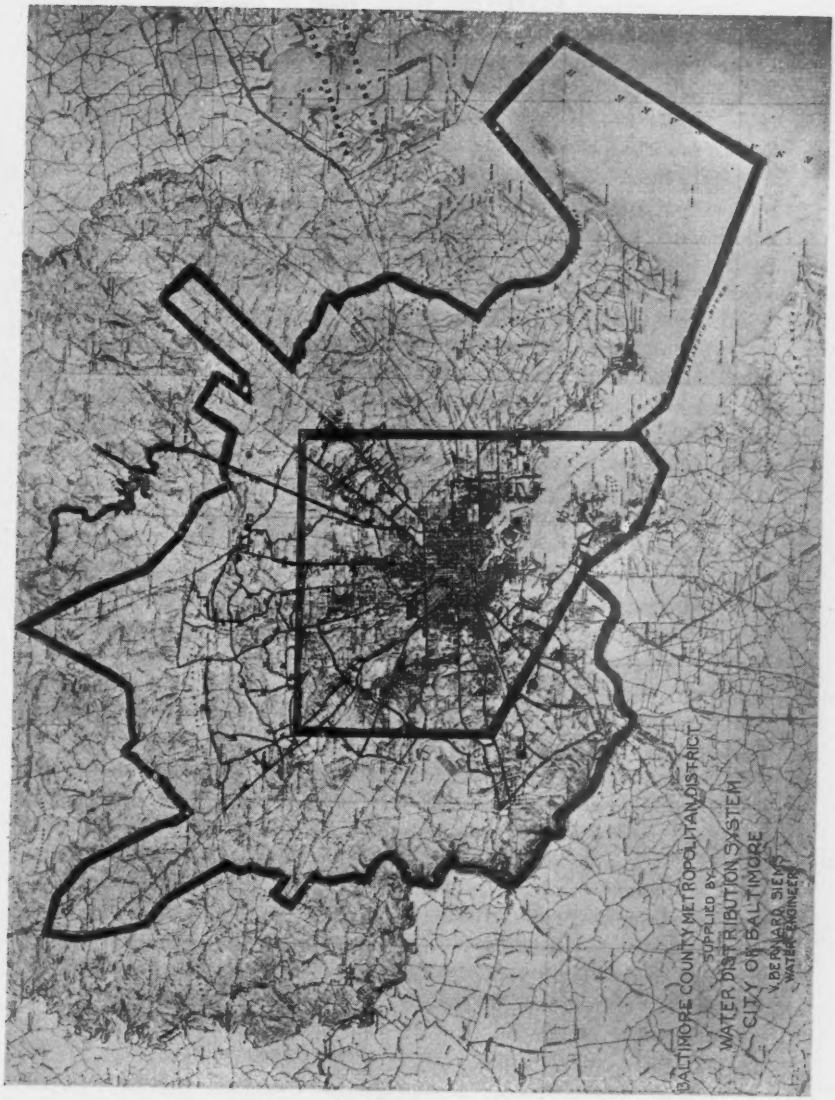
There are in Maryland four such Metropolitan Sanitary Districts. The Baltimore County Metropolitan District, recently created, is worthy of notice, as its nature is somewhat unique. In fact, the creation of this District was zealously advocated by both city and county. While this may seem unusual, since the water supply of the Baltimore County Metropolitan District is obtained from that of Baltimore City, Baltimore's interest can be better understood when I recite the experience of the City at the time of the last annexation in 1918.

The Act of the Maryland Legislature "to extend the limits of Baltimore City by including therein parts of Baltimore County and Anne Arundel County," provided for the acquisition by purchase and condemnation of any water works within the territory annexed by this Act to Baltimore City, which might be needed for any public purpose.

It so happened that there were nine private water companies operating in this territory and that part of Baltimore County contiguous to the City, supplying from 70 000 to 75 000 people with approximately 7 million gal. of water per day. The systems of the private water companies had not been designed with regard to the future development of Baltimore City's water supply, but as individual units to supply segregated areas; the water mains of these systems were neither coördinated with the City System nor with those of each other, and were not of a size sufficient to guarantee adequate fire protection; in short, these systems were not of the standard maintained by the Baltimore City Water System.

Consequently, the acquisition of these companies necessitated not alone a very large capital outlay for their purchase, but also huge capital

* Water Engineer, Baltimore, Maryland.


BALTIMORE COUNTY METROPOLITAN DISTRICT
SUPPLIED BY
WATER DISTRIBUTION SYSTEM
CITY OF BALTIMORE
BERNARD SIEMS
WATER ENGINEER

expenditures to rehabilitate inadequate systems and construct coördinating feeders and supply mains.

The subsequent $25 000 000 Water Loan of 1920 was expended in part for the purchase of the private water companies. But the money for this purpose was not economically expended on account both of inflated prices and of the necessity of the extensive scrapping and rebuilding of these plants.

To prevent a repetition of similar conditions when the next extension of the city limits occurs, Baltimore favored the creation of a Metropolitan District contiguous to the City, and was successful in seeing an Act creating this District passed by the last Legislature.

Present extensions in the County, under the Act, are financed by residents of the County. In the event of another annexation, these extensions will become the property of the City of Baltimore, which will then take over all outstanding bonds, with no expensive purchases of private water companies to consider.

Toledo has recently passed an ordinance which provides that the City may take over water lines in new annexations without cost. The ordinance further provides that the City shall not furnish water to any territory outside of the city limits unless the persons controlling this territory agree that, in the event of annexation, the city may take over the water lines without cost. Other cities follow similar procedure, — Rochester, N. Y., being the only city cited in the Toledo *City Journal* as making a practice of reimbursing subdividers for water mains in newly annexed territory. Our case is somewhat similar to that of Columbus, in that their County Sanitary and Engineering Department installs the water and sewerage systems. Baltimore City differs radically from Columbus, as indeed from most American municipalities, in that it is entirely separate and distinct from Baltimore County, whereas Columbus is a political unit and part of a county.

The County is relieved of the cost of securing, collecting, and purifying works, with inevitable delays and heavy initial expense. This is especially important, in view of the increasing trend of population to move to suburban sites in the County, adjacent to the city line. Baltimore City has practically a monopoly on the Gunpowder Falls, the only stream capable of providing large quantities of water which can be made potable at reasonable cost. The County would be compelled to construct comparatively long conduits, or drill wells to supply its needs. While still free to do so for areas so remote from the City that feeder mains would be excessively costly, it is the intent of the bill that the County secure water from the City whenever possible.

The Act which creates " A Metropolitan District in Baltimore County contiguous to Baltimore City " outlines in detail the boundaries of the District. It makes extension easy, however, in that it provides for the inclusion of any other area, contiguous to the present district, upon the application of three-fifths of the registered voters of that area. This

application must be approved by the authorities of both Baltimore City and Baltimore County.

The administration of this district is placed in the hands of the County Commissioners of Baltimore County, who are given broad powers. The Act provides for water supply, sewerage systems, and storm-water drains in the District. The Commissioners may purchase or condemn existing works, for their use, in these three utilities. They are authorized to secure engineering and clerical assistance, and may enter into agreements with the City and with the bordering Anne Arundel County for the use of the sewers and disposal works of these subdivisions of the State. The power of eminent domain enjoyed by the Commissioners extends to every part of the State excepting only the properties and privileges of the City of Baltimore and the property of the Bethlehem Steel Company at Sparrows Point. They may cause surveys, studies, and plans to be made for service, may issue bonds on the faith and credit of Baltimore County, and fix assessments on properties. The Commissioners shall annually determine the amount necessary to pay interest and sinking-fund obligations, and shall levy annually against the subdistricts of the District a sufficient tax to meet them.

No individual, firm, or community may hereafter construct water, sewerage or storm-water systems, or make extensions, except upon the written consent of the Commissioners. Public service corporations must submit detailed plans of extensions to Commissioners for approval. The Commissioners, acting through the State Board of Health, may condemn unsafe water and sewerage systems of private individuals and may compel them to connect to the District systems.

The Metropolitan District is subdivided, each subdivision being considered a unit. The Commissioners prepare plans for the extension of water mains into each subdivision, with laterals and house services. These plans are approved by the Water Engineer of Baltimore City, who thus safeguards the interests of both City and County, in that adequate mains are provided as in the standardized distribution system of Baltimore City. This insures especially adequate fire protection. The Commissioners may, at the discretion of the Water Engineer, purchase materials and contract for such portions of the actual construction as the Water Engineer may direct. In all cases, however, it is clearly the purpose of the Act that the City Water Department shall approve the design but execute all construction work at the cost of the District.

The operation and maintenance of the water system is distinctly the duty of the Water Department of Baltimore City, no provision being made in the bill for operating and maintenance forces under the jurisdiction of the County Commissioners.

The Baltimore County Metropolitan District is the fourth district created in Maryland. The Washington Suburban Sanitary District embraces territory contiguous to the District of Columbia. The Anne Arundel

County District embraces scattered developments in that county. The Salisbury District includes the city of Salisbury and adjacent rural territory. A proposed district in western Maryland will care for the collective sanitary needs of mining towns in that section. The Baltimore County Metropolitan District is unique, I believe, in that it is supplied with water by an independent municipality which is almost surrounded by the District, and whose source of water supply lies largely in the County controlling the District. The municipality lays water mains and laterals, and installs house connections, being reimbursed for all costs by the District, such costs being reviewed by the Public Service Commission of Maryland if disagreement arises. The consumers are all metered, the rates being fixed by the Water Board of Baltimore City, subject to the approval of the Public Service Commission of Maryland.

For comparison, note that the Metropolitan Water Supply Commission of Massachusetts, created in 1893, collected water and delivered it to the limits of the municipalities within its area. It constructed only impounding works and feeder conduits, leaving the extension of feeders, operation, and maintenance within the borders of municipalities to the municipalities concerned.

The Washington Suburban Sanitary District, and the smaller districts of Anne Arundel County and Salisbury, all in the State of Maryland, operate as complete units, under the State Board of Health, in collecting, purifying, and distributing water. Each district maintains engineering, clerical, and operating forces, subject to rulings of State Employment Commission.

A comparison of the methods of financing the improvements is here in order:

The Massachusetts District, constructing impounding works and main lines, pays for this work through bond issues. Interest, sinking-fund payments, and operating expenses are pro-rated against the municipalities concerned. These charges may be reviewed by the Supreme Court of Massachusetts, in the event of a disagreement.

The Washington Suburban Sanitary District pays for collecting works and feeder mains through bonds, which, in turn, are met by a direct tax levy on the district. The cost of laterals is met through benefit assessments on the abutting property owners. House services are direct charges against the owners concerned. All supplies are metered, the rates being fixed by the Commission, subject to the review of the Public Service Commission of Maryland.

In the Baltimore County Metropolitan District the taxable property is classed as Agricultural, Small Acreage, Industrial or Business, and subdivision property. .

Benefit assessments are on the front-foot basis, except that Agricultural property is not charged until service connections are made. Charges are then based on the front-foot, except that this property may not be charged for a greater length than 150 ft.

Main extensions, both feeder and laterals, are made by the City of Baltimore and charged against funds set up by the County Commissioners, as noted above under bond issues.

Each subdivision of the Baltimore County Metropolitan District is taxed for feeder mains traversing its area, through bond issues pro-rated to each subdistrict. Interest and sinking-fund payments are met by a general tax levy on the subdivision concerned. Laterals are charged as benefit assessments against abutting property owners, and house service connections are charged directly against owners. All these taxes and charges are collected by the County Commissioners who reimburse the City of Baltimore for the cost of the work done.

Operating and maintenance costs are borne by the City of Baltimore and are reflected in the rates charged consumers.

We thus see that, in so far as the operation of the water system is concerned, the Baltimore City Water Department exercises full control as in the City, and when the territory supplied is finally brought within the limits of the City, there will be no change experienced in its operation.

It is our plan now to anticipate the demands and exigencies of the future, and the creation of this District, controlled by the City, is a distinct advance.

Further, the creation of this District will benefit dwellers in the area by an advance in health and well-being. Many of these dwellers being employed by industries and establishments within the City, protection is thus extended, in a measure, to City dwellers who are in daily contact with them. As population in the District is rapidly increasing, wells and cesspools are approaching the stage where pollution is not only probable, but where many water supplies are already dangerous.

And, having attained the desired end, this fact must not be overlooked, — that too much credit cannot be given by the City of Baltimore to those foresighted engineers and legislators who advocated the establishment of the Baltimore County Metropolitan District. I refer to Mr. Robert B. Morse, who, as Chief Engineer of the Maryland State Department of Health, prepared legislative enactment as early as 1920; Mr. Nicholas S. Hill, Jr., and the Division Engineers of the Water Department. City of Baltimore, who perhaps were first to discuss such a District and whose suggestion is covered in the Final Report of the Engineers Appointed to Consider Extensions to the Baltimore City Water Supply (Hill & Fuertes), Mr. Abel Wolman, present Chief Engineer of the Maryland State Department of Health, who in 1923 called into conference a committee consisting of Messrs. Samuel A. Green, William A. Megraw, Robert B. Morse, and Walter C. Munroe, engineers representing Baltimore County, Anne Arundel County, and Baltimore City, to work out a plan for the correcting of difficult sanitary conditions in the counties adjacent to Baltimore, this group prepared the legislative act which was the basis of the bill finally enacted by the 1924 Legislative Assembly; to Hon. Howard W. Jackson,

Mayor, City of Baltimore; Hon. Philip B. Perlman, City Solicitor; and finally Hon. David G. McIntosh, Jr., President of the Maryland Senate, whose efforts were particularly responsible for the passage of the Act by the Legislative Assembly in 1924.

REINFORCED CONCRETE PIPE FOR WATER SUPPLY LINES UNDER PRESSURE.

BY COL. FRANCIS F. LONGLEY.*

[*Read October 1, 1924.*]

Until recently most of the important pipe lines for carrying water under pressure have been built of metal pipes, cast-iron, or steel. But of late a large number of such pipe lines have been built of pre-cast reinforced concrete pipe.

Each kind of pipe of course has certain advantages and disadvantages. One of the greatest disadvantages of metal pipe is that of easy corrosion, something which everyone recognizes. Persistent efforts have been made to overcome this disadvantage by the use of plastic coatings, all of which have proven themselves to be more or less perishable, permitting the corrosion or tuberculation of the iron or steel. So completely has this been proven, that the deterioration of the interior surface of metal pipe, with consequent loss of carrying capacity, is commonly expected and, with rare exceptions, is accepted as unavoidable.

Surfaces of cement or concrete for the interior of water lines have long been recognized as desirable, in that the characteristics of good concrete assure smoothness and permanence in a degree which cannot, in general, be attained in metal pipes. For many years past, sheet iron or steel pipe, lined and covered with concrete, have been used in Europe, Canada, and this country, and their freedom from internal incrustation and their durability have been very marked.

In numerous water-supply projects in the past, concrete has been used for conduits, largely on account of the large sections required — and also on account of its economical cost. But lately more attention has been paid to the permanent characteristics of these pipes and their larger permanent carrying capacity. The large number of steel conduits which have been lined and covered with concrete is evidence of the regard in which concrete of good quality is held for increasing the capacity of the pipes and acting as a preservative for the steel.

Reinforced concrete pipe, of course, is not new. Its manufacture and use for sewers, culverts, grade aqueducts, etc., dates back many years, and there are a good many hundred miles of reinforced concrete pressure pipe in use. Reinforced concrete pressure pipe in this country, however, is a comparatively new development; in fact, of only the past decade. This development has been along sound lines, based on good engineering principles. The special features of the pipe lines are rugged, simple, and highly effective.

* Of Lock Joint Pipe Co., Ampere, N. J.

It is customary to build such pipe lines under a guarantee that the leakage will not exceed certain reasonable limits, and the tests have well proven the possibilities of fulfilling such guarantees. Contract requirements generally limit the leakage to 200 or 250 gal. per in.-mile per day.

There are, of course, certain essential features in connection with the reinforced concrete pressure pipe lines: they must be built of the best quality concrete; they must be amply reinforced to withstand pressures and shocks, and — of great importance — they must possess a large degree of flexibility.

Good quality concrete, of course, means uniformity and density in order that an excess amount of leakage may not occur and a surface of uniformly good hydraulic quality may be obtained.

Ample reinforcement speaks for itself, but it is common practice that the reinforcement varies according to the pressure, using the value of ten to twelve thousand pounds per square inch in the steel, without considering the concrete.

It is obvious that flexibility in a reinforced concrete pipe line must be obtained at the joints. This means that a satisfactory joint must not only be tight under pressure, but must also allow a certain amount of movement to take place without leakage. This movement may be caused by expansion, contraction or by settlement. We are sure that in practically every pipe line of large size movement due to one or another of these conditions will occur.

With these things in mind, the Lock Joint Pipe Company has developed its pressure pipe, and at the present time make three types of pipe for water-supply lines, ordinarily known as poured pipe, cylinder pipe, and centrifugal pipe. We are now using two types of joints, generally known as lead-and-iron expansion joint, and lead-and-steel expansion joint. The large-size pipes, namely from 36-in. diameter up, are generally made by the poured process. This means the setting-up of an inner and outer form, with the reinforcement placed between them and depositing concrete on top of the forms, allowing it to run into the forms and then, after a thorough spading, allowing it to cure and set. The pipes in all cases are cured with wet steam.

For the low heads a mesh-and-bar reinforcement is used (Fig. 1). For the high heads a welded steel cylinder is moulded into the wall of the pipe throughout its entire length (Fig. 2). The pipes with mesh-and-bar reinforcement are used — according to the thickness of the pipe in question — for heads up to around one hundred and fifty feet. (Fig. 3 shows mesh cages.) Above this, cylinder pipe is used. The reason for the cylinder pipe is that poured concrete, even of the best quality, has a certain amount of porosity, and that the seepage through the walls of the pipe increases with the pressure, and reaches a point where the total loss of water is more than would be warranted. When this point is reached, therefore, the steel cylinder is used, which acts both as reinforcement and as an effective preventive against leakage.

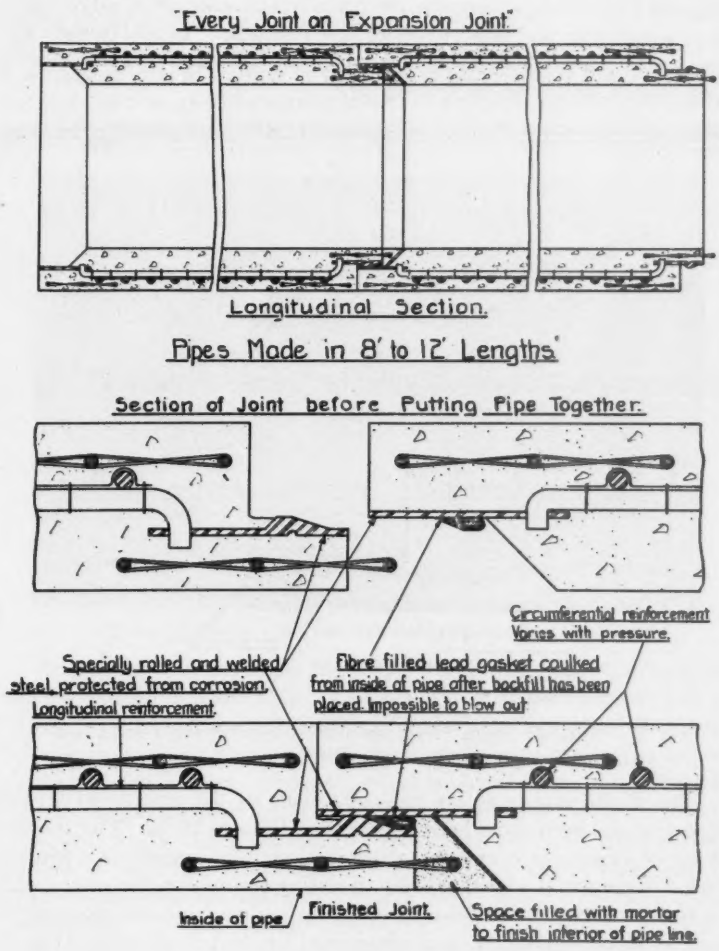

"Every Joint an Expansion Joint"
Longitudinal Section.
Pipes Made in 8' to 12' Lengths'
Section of Joint before Putting Pipe Together.
Circumferential reinforcement Varies with pressure.
Specially rolled and welded steel, protected from corrosion. Longitudinal reinforcement.
Fibre filled lead gasket caulked from inside of pipe after backfill has been placed. Impossible to blow out
Inside of pipe
Finished Joint.
Space filled with mortar to finish interior of pipe line.
Lead and Steel Joint - Sizes 36" to 108"
Pat. appld for
LOCK JOINT PIPE Co.
AMPERE, N. J.

FIG. 1. — MESH AND BAR REINFORCEMENT, AND LEAD AND STEEL JOINT.

These cylinders are welded and are also firmly connected with the joint rings before they are put into the mould, so that the real effect is of a steel pipe encased in reinforced concrete, offering a combination of the advantages both of a steel pipe and of a reinforced concrete pipe. In all outward appearance the poured and the cylinder pipe are the same. The concrete mix on poured pipe is generally 1–1½–2½.

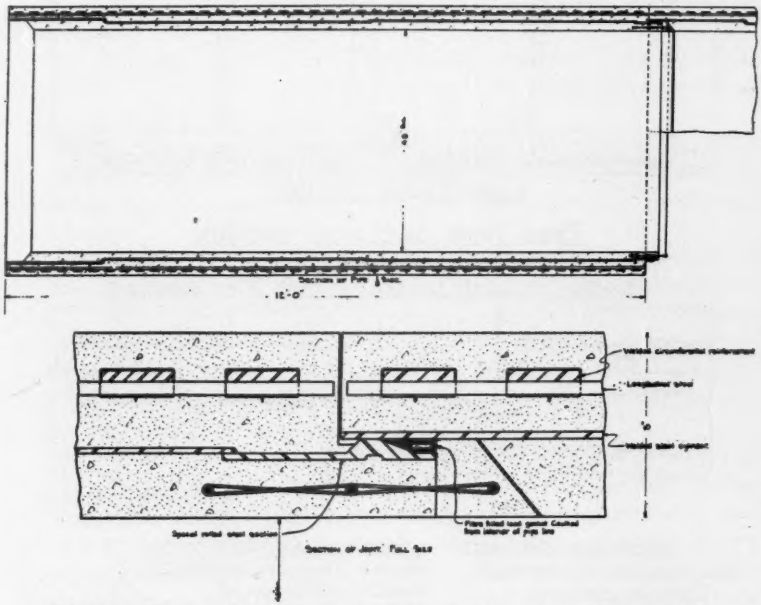


FIG. 2. — WELDED STEEL CYLINDER REINFORCEMENT WITH LEAD AND STEEL JOINT.

The smaller-size pipes are generally made by the centrifugal process. Contracts have been carried out in sizes from 16 in. to 27 in. This involves the use of an outside steel form, which is placed horizontally in a machine which will revolve it at a rapid rate, inserting concrete in the mould while it is revolving slowly and then speeding up the machine and allowing the concrete to be distributed and compacted by centrifugal force (Fig. 4). This process has resulted in a very superior quality of concrete of very great density and strength. The mix ordinarily employed for centrifugal pressure pipe is one part of cement and approximately two parts of sand.

On the face of it, it will be seen that this process does away with the one big risky element in all kinds of work, namely, the human element. When the mould starts to whirl, the packing force is automatic. It is interesting to note that centrifugal concrete made of 1 : 2 mortar mix weighs about one hundred fifty pounds per cubic foot. Another evidence of the compactness of this material is the fact that a 24-in. pipe, 3 in. thick, made

by the poured process, and a 24-in. pipe, 2½ in. thick, made by the centrifugal process, take approximately the same amount of raw material. This is due to some extent to the removal of the inert material commonly known as laitance, which, being lighter, comes to the interior surface of the pipe while being whirled, and which of course must be cleaned out. A surprisingly large amount of this material is squeezed out of the mass. But it is due also, and to a greater extent, to the high degree of compactness resulting from the centrifugal method.

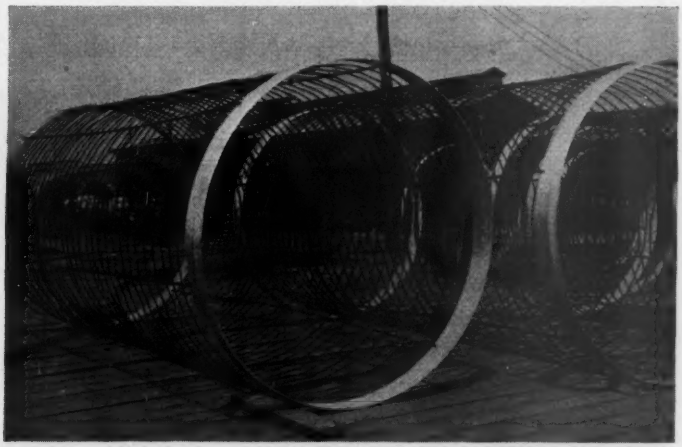


FIG. 3. — MESH CAGE REINFORCEMENT.

The centrifugal pipes are generally fitted with lead and iron self-caulking expansion joints (Fig. 5). Cast-iron rings are moulded into the ends of the pipe and are tied together by the longitudinal reinforcement. These rings are machined to certain shapes and sizes, forming the bell and spigot ends of the pipes. The lead gasket is placed in the bell of the pipe before the spigot is entered, and the mere forced entry of the spigot into the bell automatically caulks the lead in a radial direction. No hand caulking whatever is required. The spigot of the pipe being laid is forced into the bell of the last pipe by means of a simple device generally spoken of as a "pulling rig." This apparatus is shown in Fig. 6. It consists of a clamp which fastens around the pipe last laid, a strongback across the end of the pipe being laid, and two long rods, one on each side, connecting the clamp and the strongback. The end of each rod is threaded and provided with a ratchet by means of which the pipe is pulled home. This act of pulling the pipe completely seals the joint.

These joints are very flexible and will allow for a half-inch or more of expansion. The pipes can be taken apart readily without the necessity for melting the lead in the joints. A lead-and-iron expansion joint is herewith shown. (Fig. 5.)

The lead-and-steel joint which is used on the larger sizes of pipe embodies somewhat the same principle but has to be caulked by hand. A very marked departure has been made from the regular run of joints in that the caulking is all done from the interior of the pipe, and can be done any time after the pipe has been laid, backfilled and allowed to settle. Engineers will appreciate the great advantage of being able to make joints after settlement has taken place, rather than to have settlement strains thrown on finished joints. In the bell end of the pipe there is moulded a galvanized steel band generally 6 in. wide and $\frac{1}{4}$ in. thick. In the spigot end there is moulded a steel band of a special section so that when pipes are laid there is a wedge-shaped cavity formed between these two bands into which

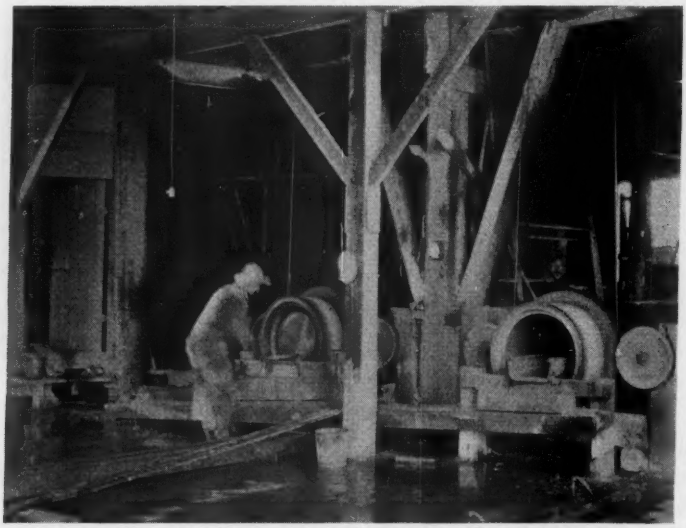


FIG. 4. — PIPES MADE BY CENTRIFUGAL PROCESS.

cavity is caulked a special fibre-filled gasket (Fig. 7). It will be seen from Figs. 1 and 2 that it is impossible for this joint to blow out. The pressure is constantly tending to wedge the gasket more tightly into its seat between the joint rings.

The mortar filling for the joint recess is not for the purpose of tightness, but simply for the purpose of making the pipe line smooth.

The joint rings are very accurately made, and the clearance between the bell and the spigot on a 60-in. pipe is only $\frac{1}{16}$ of an inch. This pipe lends itself to very rapid laying. We have frequently laid more than fifty pipes, 60-in. diameter, with one crew in eight hours, each pipe being 12 ft. long. The trench can be immediately backfilled and the joints made any time thereafter.

On the Spavinaw project which we have just completed for the city of

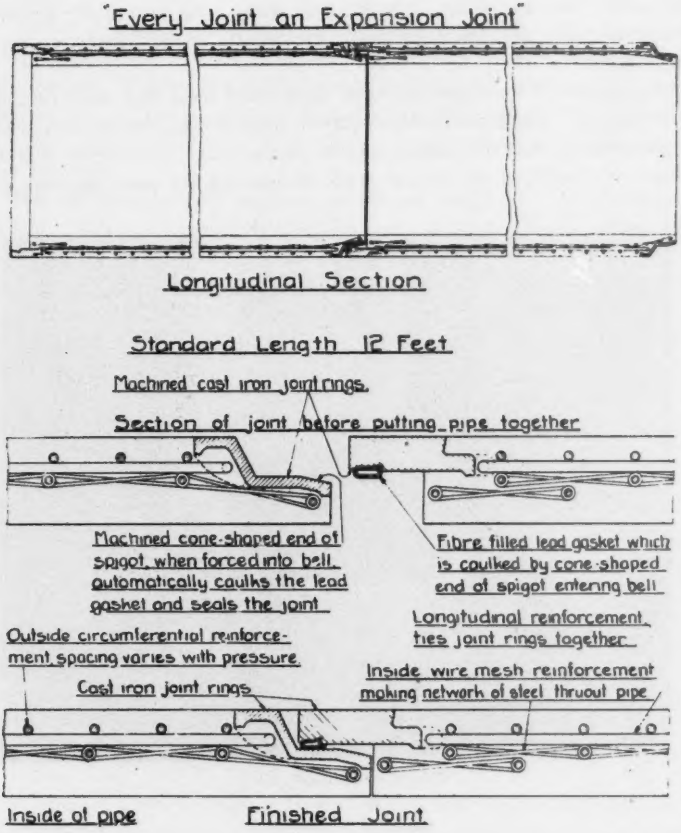

"Every Joint an Expansion Joint"
Longitudinal Section
Standard Length 12 Feet
Machined cast iron joint rings.
Section of joint before putting pipe together
Machined cone-shaped end of spigot, when forced into bell, automatically caulks the lead gasket and seals the joint
Fibre filled lead gasket which is caulked by cone-shaped end of spigot entering bell
Longitudinal reinforcement ties joint rings together
Outside circumferential reinforcement spacing varies with pressure
Inside wire mesh reinforcement making network of steel thruout pipe
Cast iron joint rings
Inside of pipe
Finished Joint
Centrifugally made reinforced concrete pressure pipe with lead and iron self caulking expansion joint
Patented
LOCK JOINT PIPE Co.
AMPERE N. J.

FIG. 5.

Tulsa, 25 miles of pipe were laid, backfilled, and allowed to settle before joint-making started (Fig. 8). This feature was particularly valuable in this country because of the very dry and dusty condition of the ground in the summertime, and the consequent probability of settlement during the rainy season.

A number of subaqueous water lines have been laid with reinforced concrete pipe. The lead-and-steel type of joint which is being used, permits the gasket to be caulked tightly into its proper place, even under water, by divers. To facilitate the divers' work in drawing the pipe together under

FIG. 6. — PULLING RIG.

water, a heavy bolt is placed at each side of each joint through eye-bolts set into the walls of the pipe. This is shown in Fig. 9.

One often hears it said that concrete is not a suitable material for pipe to carry water under pressure. Upon further inquiry it usually appears that this opinion is based upon some unfortunate experience or upon the impression gained from seeing ordinary concrete pipe in different parts of the country. It is often difficult to convince the skeptic that reinforced concrete pressure pipe — as it is now made — is quite a different thing from what he has in mind.

In the first place, everyone knows that the quality of concrete in pressure pipes must of necessity be of the very best, and uniformly of the very best. This naturally calls for the most careful selection of materials, the most careful manipulation of them and for equipment especially designed for obtaining the best results. In addition to all this, and of very great

importance, is the attitude of the organization building such pipe and pipe lines.

The problems involved are all perfectly practical, but extreme care must be taken from the beginning to the end, both in the manufacture and in the laying. This means that the men on the work must not get tired of doing the things right all the time and must be fully alive to the importance of having every detail correct, realizing what a relentless thing is water under pressure.

The characteristics of concrete which are vital to its use for pressure pipe are: density, water-tightness, and smoothness. For a great many

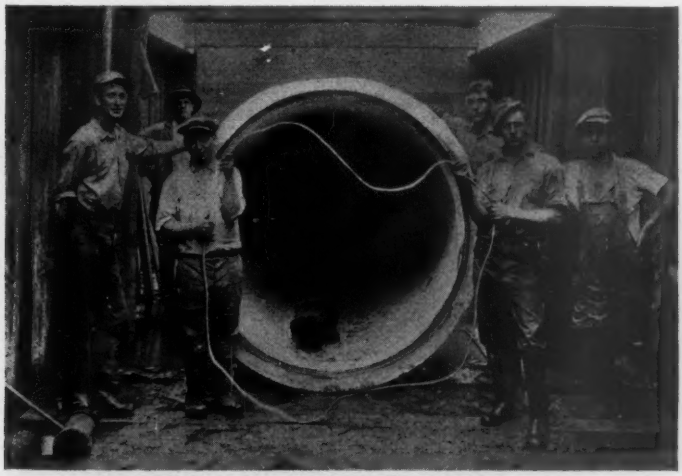


FIG. 7. — SPECIAL FIBRE-FILLED GASKET.

uses to which concrete is put, a lack of the highest degree of perfection in these characteristics does not seriously affect the value of the concrete, and since it takes time and trouble and additional expense to attain the highest degree of perfection in these respects, no special effort is made to do so in a great deal of concrete work. The qualities of concrete are, in fact, as varied as the flowers that bloom in the spring, and we are all of us familiar, no doubt, with many examples of very rough and porous concrete and perhaps have wondered, at times, how the fellow responsible for the work managed to get away with it.

Through years of experience the vital importance has come to be realized, more and more, of a high decree of density and strength, a high degree of water-tightness, and a thoroughly smooth hard surface, for the concrete used in water lines under pressure, and measures are taken to attain the greatest possible degree of perfection in these respects. This is not done merely because So-and-So's specifications call for it, but because experience in building water lines has brought the conviction that this is the

only way that reinforced concrete pipe can come into its own. The Lock Joint Pipe Company uses certain methods which some of its friends have predicted would be the ruination of its profits, but the end has certainly justified the means, and the trouble and the expense involved in attaining it.

The proportion of cement used in the concrete in good pressure pipe is high. The mix commonly used is 1 to 1.5 to 2.5. These proportions for the materials used result in the use of about 2.3 barrels of cement per cubic yard of concrete. The bell and spigot of each length of pipe are regularly enriched by the use of a rich cement mortar and this serves to increase the proportion of cement somewhat. The pipes are cast between steel moulds

FIG. 8. — PIPE LINE FOR CITY OF TULSA, OKLAHOMA.

which are made without projections of any sort against the concrete. They are always kept clean and smooth and well oiled, and thus the surfaces of the concrete cast against them are very smooth.

The greatest care is always used in the selection of aggregate and sand. Very coarse stone or gravel cannot be used because of the difficulty, or even impossibility, of getting it to settle nicely about the reinforcing and completely fill every cubic inch of space within the forms. The material commonly used is clean gravel or crushed stone which will pass a 1-in. screen. On certain recent work we have been taking a hard, clean quartz sand out of a sand pit, which many contractors would think themselves very lucky to own and to use just as it came, and we have put this sand through heavy rolls of Chrome steel. The result of this is a sand which is nicely graded from coarse to fine with a sufficient amount of very fine material to assure

an intimate physical contact of cement particles with fine sand particles, giving a high degree of density, water-tightness, and smoothness of surface. The following figures show the results of mechanical analysis of this ground sand:

RESULTS OF MECHANICAL ANALYSIS OF TWENTY-ONE SAMPLES OF GROUND SAND USED IN MAKING LOCK JOINT PIPE.

Size of Sieve.	Percentage passing: Average.
¼-in.	100.
10 per inch	96.7
20 „ „	67.0
30 „ „	42.4
40 „ „	30.9
50 „ „	22.8
100 „ „	12.9
200 „ „	6.1

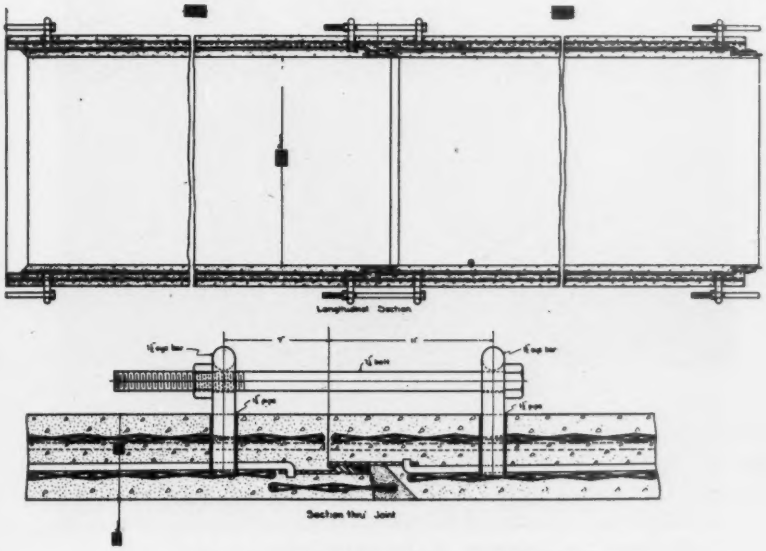


FIG. 9. — PIPE TO BE LAID UNDER WATER.

It is important to note that all the finest material of this specially prepared sand is made up of hard resistant particles and does not consist of clay, humus, or dirt, which commonly makes up the fine material in sand. An examination of the finest particles under the microscope shows the hard glinting surfaces characteristic of crushed quartz.

It is interesting to note that the specifications for the filter plant now under construction at Denver, Colo., call for ground sand. This process of special sand preparation is not necessary in all cases, but where the sand

is coarse or poorly graded, the expense of crushing it is more than justified by the improved quality of concrete obtained.

It is this combination of precautionary measures, along with various others, which result in producing the high degree of density and strength, water-tightness, and smoothness in the concrete in water-pressure lines as built today.

Flexibility of the lead-and-iron and the lead-and-steel expansion joints permits the standard 12-ft. lengths to be laid on most of the vertical and

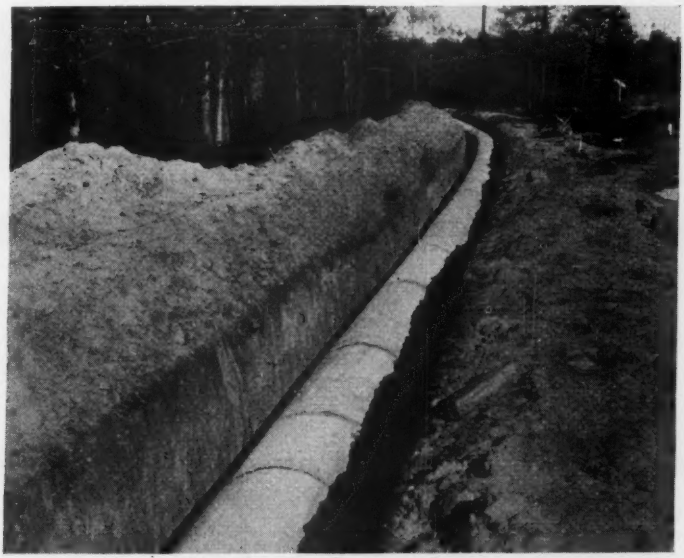


FIG. 10. — PIPE LAID ON A CURVE.

horizontal curves met in water-supply lines. A pipe line laid on a curve is shown in Fig. 10. The limiting radius of curvature which can be made in a pipe line depends upon

1. Length of each piece of pipe;
2. Diameter and thickness of the pipe;
3. The distance that the bell and spigot of two contiguous pipes can be separated from snug contact at the joint on the convex side of the curve.

The standard length of pipe is 12 ft., as just stated, and therefore for the usual case this factor is fixed. A consideration of the second factor will show that it is made up of the inside diameter, plus the thickness of the wall of the pipe, plus the thickness of the spigot, and the total of this factor will, of course, vary for different sizes of pipe. The third factor is fixed by practical consideration of tightness and safety at the joints. For lines laid until recently a maximum opening of $\frac{3}{4}$ in. at the joint on the convex side of the curve has been considered a safe limit.

Based on a maximum opening of $\frac{3}{4}$ in. and the other factors as indicated, the limiting radii of curvature can be computed, and they are set down below for diameters from 36 in. to 90 in.

For standard 12-ft. lengths of pipe and for diameters of pipe as follows:	Radius of curvature can not be less than about
Inches	Feet.
36	675
42	785
48	885
54	990
60	1 100
66	1 165
72	1 310
78	1 415
84	1 515
90	1 615

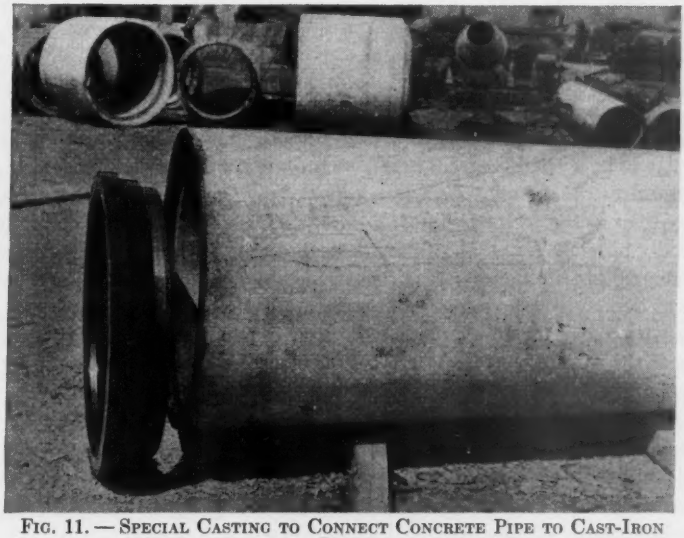


FIG. 11. — SPECIAL CASTING TO CONNECT CONCRETE PIPE TO CAST-IRON PIPE.

Certain changes have recently been made in the design of bell and spigot steel rings which permit a maximum opening somewhat greater than $\frac{3}{4}$ in. Where these changes are applied in building a new pipe line, it may therefore be possible to lay the line on curves of shorter radius than those indicated.

Where the curves are of too short a radius to allow the use of the standard lengths, the pipes are sometimes cast in shorter lengths, permitting a shorter radius of curvature. Sharp bends in the large sizes are made by casting them in place in the trench. This method eliminates the necessity

for expensive cast-iron fittings and greatly facilitates the layout of the line, as the bend can be built to any angle and made to fit the best location of the line. As the bend is cast against the trench walls, it more effectively withstands the unbalanced pressure load than does the pre-cast bend which is placed and backfilled in the usual way. In lines of small diameter, cast-iron specials have been used. Wherever it is desired to connect the concrete to a cast-iron pipe, the concrete pipe is made with a cast-iron ring in the end which is of the same shape and dimensions as the standard cast-iron bell or spigot; or the connection can be made by means of a special casting as shown in Fig. 11. The joint is then made in the usual manner of making the cast-iron pipe joint.

It is customary for engineers to consider the merits of concrete pipe for water-supply lines under the following headings:

1. Hydraulic qualities;
2. Water-tightness;
3. Durability;
4. Cost;
5. Justification for its use.

Hydraulic Qualities.

A high coefficient of flow in a water-supply line is "a consummation devoutly to be wished"—to illustrate so prosaic a subject with the words of Shakespeare. If among the various types of pipe generally used for water-supply lines in the past one had been found to have a coefficient of friction decidedly more favorable than the others, both in its initial state and, more particularly, as the years passed, that pipe would undoubtedly have been in great demand. The size of pipe required to deliver a given quantity of water with a given head available is directly dependent upon the hydraulic value of the interior surface. The better the surface, the smaller the pipe; the poorer the surface, the larger the pipe.

Among metal pipes used for large water-supply lines, there has not been any one kind which stood out conspicuously from the rest on account of the better hydraulic properties of its surface, although different hydraulic values have been recognized; as, for example, that due to different methods of joining plates in steel pipe.

Broadly speaking, so far as character of interior surface is concerned, it has been common to consider new metal pipe of the same diameter but of different type approximately equivalent in carrying capacity.

The pressure pipe lines of pre-cast reinforced concrete built during the last few years have exceedingly smooth, hard, durable interior surfaces which put them clearly into a different class, and a better class, than pipe lines of iron or steel, so far as carrying capacity is concerned.

The methods of manufacture of lock joint pipe assure favorable coefficients. In casting the pipe, the concrete is placed against well-oiled steel forms which are built with all rivet heads countersunk. The pipes

have true circular surfaces and the bell and spigot ends are so built as to be truly concentric. The finished interior joints are very smooth with no offsets such as are frequently found at joints in pipe lines. It is worth while to note that the present high degree of perfection in this respect is the result of painstaking developmental work and trying experience, and for the benefit of those who have had long familiarity with reinforced concrete pipe it may be said that, in this respect, the water-supply lines made of this pipe today are decidedly better than they were some years ago.

In the early days of manufacture of concrete pipe it was no uncommon thing to find the inner and outer surfaces lacking in true circular shape, and in being truly concentric. In some old lines this resulted in imperfect alignment of surfaces at the joints, the elements of one pipe frequently being $\frac{1}{2}$ in. or even $\frac{3}{4}$ in. or more offset from the elements of the contiguous pipe. The joints of such a pipe line therefore presented projections, partially smoothed, it is true, by the mortar of the joints but presenting, nevertheless, irregularity of surface and variations in area of cross-section, sufficient to cause a reduction in the coefficient of discharge, for the same reasons commonly recognized as reducing the coefficient of discharge of lap-welded, riveted steel pipe. Through a number of years past a determined effort has been made to overcome this defect, and the best methods of pipe manufacture used today result in truly circular surfaces which are accurately concentric. The application of a straight edge across the joints on the inside of certain old concrete pipe shows conspicuous offsets. An examination recently made by the writer of a large number of joints in the 53 miles of 54-in. and 60-in. pipe line which we are now about completing for the city of Tulsa, Okla., shows no measurable offset. On the great majority of the joints the straight edge was in perfect contact across the joint and on both sides. In only occasional cases was there an irregularity as great as $\frac{1}{16}$ in., and irregularities as great as $\frac{1}{8}$ in. were very rare. In walking along the inside of the pipe and letting one's hands glide along the surface it was difficult, and in places impossible, to distinguish the joints from the smooth barrel of the pipe by any difference to the sense of touch. This may seem a remarkable statement, yet it is a fact; and the perfection of shape and surfaces and of joint work amply justify it.

All the evidence points to a greater degree of permanence of good hydraulic qualities in well-made concrete pipe than in metal pipes. The important underlying fact is that there is a fundamental difference between concrete and steel or iron, as these metals are, in general, liable to deterioration as a result of slow but persistent chemical action in contact with waters such as are commonly used for public water supplies: while concrete, if properly made of suitable materials, is not, in general, liable to chemical action and deterioration of this sort in contact with such waters. Concrete is generally ranked as a most durable material, and engineers are in the habit of using it where permanency is desired.

In considering the merits of concrete pipe is is obviously necessary to

discriminate between conditions which are *known* to involve some risk of deterioration, and the far more common conditions met with in water-works practice which do not involve such conditions. The fact must not be lost sight of that those conditions which tend to affect good concrete, will also attack any other pipes in general use in water-works practice.

The outstanding point is that a good, hard, smooth concrete surface is not liable to the corrosion and tuberculation which is looked upon as inevitable in iron or steel pipes, and therefore high-grade reinforced concrete pipe may confidently be expected not only to show a high carrying capacity when new, but also to maintain that high carrying capacity through a long term of years.

The building of large water-supply pipe lines of reinforced concrete pipe having the good hydraulic qualities which can today be assured is a matter of only recent years, and therefore there is but little information in the way of accurate records to show the value of C and, especially, to show what variation, if any, delvelops in this value as the years pass. Considering the cement-lined pipes which have been used for a great many years for water mains in a number of cities of the United States, there is ample evidence in the way of verbal statements from water-works superintendents who have used such pipe, that its interior surface remains clean and smooth; but there appear to be no precise observations to show the value of C in such mains through a long term of years. The reasons for this absence of precise observations on such mains are well enough known to water-works engineers and need not be repeated here.

The most comprehensive summary of the result of tests on concrete pipe lines is given by Scobey (Bulletin 852, Bureau of Public Roads). Among the numerous records he presents, there are a few which show the values of the coefficient C on the same pipe lines at times separated by intervals of from two to four years.

SUMMARY OF SCOBEY'S DETERMINATIONS OF VALUE OF C ON CONCRETE PIPE LINES TESTED AT INTERVALS OF TIME.

	Inside diameter: in.	Length of pipe under observation: ft.	Time between first and second sets of observations: years.	C IN WILLIAMS-HAZEN FORMULA.	
				First set observations.	Second set observations.
Deer Flat Forest pipe line Boise project, Idaho...	36	7 282	2	121.2	136.0
R, siphon, Umatilla project, Oregon.....	46	9 772	3 to 4	138.3	151.5
D, siphon Umatilla, Oregon	30	5 026	4	144.0	122.8

The first and second of these show higher values of C at the later tests than at the earlier. The third shows a lower value at the later tests, but Scobey notes that this diminution was to be expected on account of deposits of silt and debris in the pipe.

The writer is not disposed to claim from any of the above figures that water-supply engineers would be justified in expecting an *increase* in the coefficient C as time elapses, although two of the sets of figures seem to indicate an increase. That point is better left for answer with the accumulation of data which will result with the increasing use of reinforced concrete pipe during the next few years. The figures may clearly be interpreted, however, as lending support to the claim that the qualities inherent in smooth, hard, well-made concrete surfaces assure the more or less permanent maintenance of a high value of C. This is a point of vital importance in the economics of pipe-line design, and carries weight especially in the consideration of size of pipe required to deliver a given quantity of water at some time, — say 10, 15, or 20 years in the future.

Scobey's paper shows the value of the coefficient C (Williams-Hazen formula) for some 44 sets of observations of flow in various pipe lines. These are set down here in order of magnitude to show how high the coefficient runs in concrete pipe with smooth interior surfaces.

Inside Diameter in Inches.	Length of Pipe under Observation: Feet.	C. Williams-Hazen.	Extracts from remarks in Scobey's Paper descriptive of roughness of inside surface and joints and of methods of manufacture.
42	378	155.1	" tamped into steel forms," " forms well wiped with oil prior to each pouring," " interior surface — unusually smooth " " joints as smooth to the touch as the rest of the pipe."
216	6 466	152.8	" The surface of pipe is unusually smooth and even," " great care was taken to see that the concrete was carefully spaded next to the oiled steel forms."
46	9 774	151.5	" The units were cast in steel forms," " pipe straight in alignment."
63.5	1 138	146.8	" Steel used for interior forms," " project manager inspected the pipe and found the interior in a very smooth, clean condition — in eighth year of operation."
31.5	131	146.5	" joints perfect."
30	–	144.0	" pipe units were each 4 ft. in length, cast in wood forms that had been coated with No. 26 sheet steel."
110	–	142.7	
42	1 336	141.7	" tamped into steel forms," " forms well wiped with oil prior to each pouring," " interior surface — unusually smooth," " joints as smooth to the touch as the rest of the pipe."

Inside Diameter in Inches.	Length of Pipe under Observation: Feet.	C. Williams-Hazen.	Extracts from remarks in Scobey's Paper descriptive of roughness of inside surface and joints and of methods of manufacture.
46	9 831	138.3	"The units were cast in steel forms," "pipe straight in alignment."
174	8 419	136.8	"lining — deposited against clean, oiled steel forms, being carefully spaded near the forms to assure a dense, smooth inner surface," "surface somewhat foul."
36	7 282	136.0	"The pipe units 6 ft. in length, were cast on the ground in steel forms," "joints caulked on inside with great care, the mixture being one part cement to two of sand — "
86.6	4 200	135.6	"Original data do not describe pipe manufacture or surface."
54	2 167	129.4	Description of pipe not given in Scobey's paper.
23.8	1 046	127.3	"The pipe was constructed with wood forms, both inside and out. The longitudinal ridges made by the cracks in the boards, the circular ridge at the end of one setting of the forms and cemented concrete scraps are shown in Plate II, Fig. 2, which was photographed—"
30	–	126.0	Comparing this 30-in. with 16-in. used on same work, notes say, "All sizes are grouted on the inside, but the grouting of the large size is more smooth — "
20	2 163	125.0	"Pipe units 3 ft. long." "All units were washed with cement grout before being laid." "So far as could be determined — joints were well smoothed and this pipe is probably typical of present-day careful practice (1911)."
30.5	2 276	123.3	"The joints were not quite as nearly perfect as on the Victoria line, and this probably accounts for some of the discrepancy in relative carrying capacities." "Steel forms coated with — oil gave a smooth surface to the interior of the pipe."
30	5 026	122.8	"pipe units were each 4 ft. in length, cast in wood forms that had been coated with No. 26 sheet steel." "The values of C_s, about 0.330 are probably indicative of the silted condition within a smooth pipe rather than of the interior surface itself."
12	869	121.6	
20	–	121.4	
36	7 282	121.2	

Inside Diameter in Inches.	Length of Pipe under Observation: Feet.	C. Williams-Hazen.	Extracts from remarks in Scobey's Paper descriptive of roughness of inside surface and joints and of methods of manufacture.
36	1 933	118.6	
120	857	117.7	
19.7	772	115.8	
18	4 242	111.0	
16	1 897	109.7	
16	–	109.5	
18	559	106.6	
16	854	106.5	
12	218	103.3	
36	1 256	102.1	Wooden forms.
8	1 311	95.7	Clean, but with rough joints.
24	2 306	95.4	Gravel deposits in pipe.
16	785	95.3	Surface and joints not described.
19.7	1 116	94.2	2-ft. lengths. Joints very rough.
29.9	880	93.1	3-ft. lengths. Surface and joints not described.
10	1 107	93.0	No sediment. Joints not described.
10	936	91.9	No sediment. Joints not described.
12	218	90.7	2-ft. lengths.
18	133	90.2	Made by inexperienced men. Sediment in pipe.
18	559	88.6	2-ft. lengths.
12	621	87.5	Poor joints, rough interior surface.
11.8	1 851	86.2	Rough joints, constructed by new man in business.

The fact that some tests of the hydraulic qualities of reinforced concrete pipe show low coefficients, need not be taken as an argument against the adoption of good reinforced concrete pipe. It may rather be taken as an evidence of the use of imperfect construction methods in such cases, as is evidenced by Mr. Scobey's remarks. Concrete pipes made with smooth interior surfaces are well known to give favorable friction coefficients. If we examine the results of tests summarized by Williams and Hazen in their Hydraulic Tables we will find a confirmation of the high values quoted above from Scobey, showing the high quality of interior surface of which good concrete is capable. The importance of this point cannot be too strongly emphasized. It is certainly of great importance to discriminate between pipe which has a smooth, hard surface, almost vitreous in its appearance and with no unevenness at joints, and a pipe whose

surface is conspicuously rough and uneven; and the water-pressure lines built today by the most improved methods have interior surfaces of high quality which assure large carrying capacity.

The tests made by Scobey were on pipes of a wide range of quality and of lengths of from 2 to 8 ft. From familiarity with the methods used today, together with the longer lengths, namely 12 ft., the writer is satisfied that up-to-date tests will show results better than those quoted by Scobey in his paper.

WATER-TIGHTNESS.

In considering the question of water-tightness of a pipe line, one has to remember, first of all, that there is a vast difference between a pipe and pipe line. The barrel of the pipe may be entirely impervious and yet a large quantity of water may be lost from imperfect joints — witness the common experience of leakage from cast-iron pipe lines which occurs normally at the joints.

We must therefore consider the question of water-tightness of reinforced concrete pipe lines from two points of view: First, of imperviousness of the concrete forming the barrel of the pipe and, second, the tightness of the joint.

As the design and construction of concrete pipe lines under pressure has developed, perviousness in the concrete has been noted, as might well be expected, especially in the early days. The problem of producing a high degree of imperviousness has been studied hard and carefully from experience, and a high degree of tightness has been attained, partly by the use of the measures already set forth and partly by the carefully considered design of the steel reinforcing the concrete. The net result of all of this has been to produce a barrel in the pipe which will withstand a substantial internal pressure without a substantial leakage of water visible at the outer surface. The results of leakage tests, as shown in the table, give ample evidence of the successful attainment of a thoroughly tight pipe.

RESULTS OF LEAKAGE TEST ON LOCK JOINT PRESSURE PIPE LINES.

Location.	Diameter: In.	Head, ft.	Leakage in Gal. Per In. Diameter Per Mile Per Day.	
			Allowed by specifications.	Measured on test.
Dallas	36	30–80	225	118
Fort Worth	48	20–60	275	115
Hartford	48	50	225	205
Milwaukee	72	40–52	225	74
Winnipeg	66	45–95	225	73
Kansas City	48	100	350	292
Norfolk	36	30–120	185	83.6
Denver	54	30–120	167	141
East Orange	20	114	225	93
Greeley, Colo	27	30–108	240	142
Baltimore	84 and 108	80	256	88

In the early days of concrete pipe construction the logical material for the joint appeared to be cement mortar. Under ideal conditions it is possible to make a cement mortar joint tight enough to hold water, against considerable pressure. Unfortunately, however, ideal conditions are rarely met with in laying a pipe line in a long trench. For a mortar joint to be tight and to remain tight one must have perfect immovability in the pipe line, or at least no relative movement between pipes at the joint. One must have perfect conditions of saturation of the concrete of the pipes with moisture at the time the mortar joint is made, in order to prevent the withdrawal of an undue amount of water from the fresh mortar. In making mortar joints, dry pipe surfaces have frequently been observed to take most of the water out of the mortar placed in contact therewith, — just as a blotter will absorb water, — and this left the mortar in a dry, lifeless condition and resulted in a very imperfect joint. One must always have a trench practically free from water in order that a mortar joint will be compact, dense, and water-tight. Ground water rising in the trench about a new mortar joint, even several hours after the fresh mortar is placed, is almost certain to damage the desirable qualities of the mortar if not to make it slump completely out of the joint.

These and various other considerations have brought home the conviction that dependence cannot be placed upon cement mortar joints, if a uniformly high degree of perfection and tightness is to be attained in the joint work of a pressure line. On account of their commercial impracticability the Lock Joint Pipe Company have therefore abandoned them. For all their pressure work they now use a joint of metal upon metal, that is, lead upon steel or cast-iron. These joints have been described above.

These joints are tight, flexible, simple, rugged, and durable. A comparison of the measured leakage from recent concrete pressure pipe lines, with leakage recorded from other kinds of pipe lines, shows that the results are most favorable and that a city contemplating the installation of a pipe line is well assured of a minimum loss of water either from the body of the pipe or through the joint, when such concrete pipe lines are provided with effective expansion joints.

An outstanding fact which experience has taught is that every joint in a reinforced concrete pressure line must be an expansion joint. Concrete contracts in volume as its temperature is reduced. As a result, a reinforced concrete pipe line, built without expansion joints, opens up and leaks at the joints when subjected to low temperature. Early in its experience with pressure pipe, the Lock Joint Pipe Company built two water lines, without expansion joints: one, the 42-in. Sooke Lake line for the city of Victoria, B. C., and the other, a 108-in. line for the city of Baltimore. Both of the lines leak from the joints during the winter. As a consequence, this Company has developed the effective expansion joints, previously described, and absolutely refuses to build a pressure line without expansion joints in every joint. Early in this work careful study was made to determine

the feasibility of placing expansion joints at short intervals in the line. Minute examination of the location of contraction cracks in lines which had been in service and undergone seasonal temperature changes showed that the cracks occurred very irregularly throughout the line and that expansion joints, placed at intervals as frequent as at every other joint, were found to be insufficient, contraction cracks actually appearing in the intermediate joints between two expansion joints. Placement of a concrete line deep in the ground does not remove the necessity for expansion joints. While the ground at that depth may remain at a fairly constant temperature throughout the year, the pipe undergoes the same temperature changes as the water it carries. Made in a 12-ft. length and undergoing a maximum annual temperature change of 50° Fahrenheit, contraction of a single length will amount to approximately $\frac{1}{24}$ in. Each of the joints described can, if necessary, move one-half inch or more without leaking. The importance of expansion joints in every joint cannot be overemphasized:

The durability of the joint follows from the nature of the materials and their position in the structure. The iron or steel rings forming the bell and spigot ends of the pipe are built into the concrete in a way to insure their preservation. The gasket of lead forms a contact between two concentric circles of cast iron or of galvanized steel. The portions of these metals exposed after the joint is caulked are commonly covered with cement mortar in the process of finishing the joint.

Durability.

The question of durability has already been touched upon in the discussion of hydraulic qualities to which the point is closely related. If we consider durability from the point of view of the continued life of the structure in a safe condition through a long term of years, it is but natural to hold that concrete has the greatest permanence. If it had not, what would become of the great majority of modern structures in which concrete is used in the most critical positions? To be sure, failures of concrete structures occur now and then, but so do failures of bridges, of dams and of other engineering structures. But are not such failures always attributable to some cause, or causes, more or less well known?

The point is sometimes raised as to the durability of the steel built into the wall of the pipe. If this point is brought into question, it would seem to cast doubt upon the stability and permanency of a great variety of structures built of concrete. A sufficient answer would seem to be the long and successful use of reinforced concrete structures when properly built.

One might theorize at length upon this point. Much has been written regarding the protective nature of concrete to the steel reinforcement. A vast accumulation of experience undoubtedly already shows a high measure of protection. One of the points which the Lock Joint Pipe Company considers of great weight in assuring the integrity of reinforcing steel built

into its pipe, is the simple fact that the design and the unusually careful methods of construction effectively prevent any continuing contact of water and any replenishment of oxygen carried by the water to the surface of the steel. Steel in contact with water whose oxygen content is being continually replenished will inevitably rust. Steel in contact with water in which there is no possibility for the replenishing of oxygen can show no progressive rusting. This is undoubtedly the condition pertaining at the steel surface embedded in the concrete of Lock Joint pipe. Time and again this steel has been exposed for one reason or other after a more or less prolonged opportunity for rusting to take place, if it would, but the steel thus exposed always presents a surface quite as free from rust as when it was placed in the pipe. Instances of this protective action of steel, due to the exhaustion of oxygen in the water in contact therewith and its non-replenishment, are not uncommon.

The writer has on a number of occasions observed, for example, steel pipe from which the interior coating had become separated, like a projecting blister, but not actually broken. The blister in each case was full of water. The appearance and smell of this water was convincing evidence that the oxygen was completely used up, perhaps in oxidizing the surface of the metal or perhaps in other processes of oxidation. The smooth, bright surface of the metal itself, however, was the most convincing evidence that oxidation had been limited in quantity and had been brought to a complete standstill due to the fact that there was no way for the contained water to have its oxygen replenished.

Another interesting and simple example of the same sort came recently to the writer's attention in connection with an examination of the 350-mile steel pipe line supplying water to the gold fields at Coolgardie and Kalgoorlie in southwestern Australia. This long pipe line has suffered severely from corrosion from the very beginning of its use. In some portions of the line, the tuberculation is so heavy that there are hundreds of tubercles per square foot. The carrying capacity of the pipe in a number of test sections has diminished 50%, more or less.

In one length of this pipe, removed for cleaning and repairing some time ago, a small piece of iron, several inches wide and some two or three feet long, was found lying on the bottom. Underneath it was a quantity of black, ill-smelling liquid, and the surface of the pipe in the area covered by this piece of metal was as smooth and as free from tuberculation as the day it was installed, with innumerable tubercles all around it, thus showing the protective effect resulting from limitation of oxygen supply in the water in contact with the steel underneath the iron plate.

While referring to Australia, the writer wishes to note that the development of reinforced concrete pipe for pressure lines in Australia has advanced rapidly during recent years in the hands of the Hume Pipe Company. Their work appears to be highly successful and has met the approval of water-works engineers and officials. It is interesting to note that the thickness

of the concrete wall commonly used in the Australian pipe is considerably less than the thickness adopted by the Lock Joint Pipe Company.

Experience of various sorts affords a presumption of durability of concrete pipe. Concrete sewers have long been used with success, and certain known conditions which might contribute to the failure of reinforced concrete pipe are far more often met with in sewers than in water-supply lines. There is also a history of a good many years of concrete used successfully in one way or another in connection with water lines in this country. In France there is a history of successful use of reinforced concrete pipe under pressure, covering at least thirty years. The Australian experience, just referred to, has presented nothing to cast doubt upon the durability of reinforced concrete pipe.

While it may be quite natural for water-works engineers and superintendents to proceed cautiously in the adoption of a kind of pipe which can show a continued period of successful experience which is limited in comparison with the experience of some other kind of pipe, it is clear that both good experience through a considerable term of years, and presumption based on the most careful design and methods of construction, indicate convincingly that well-built reinforced concrete pipe lines are durable and safe.

Cost.

It would be somewhat difficult to generalize regarding the cost of reinforced concrete pressure pipe lines for water supply. Just as in the case of other kinds of pipe lines, the cost is influenced, to a greater or less degree, by conditions pertaining to each job.

In deciding upon the kind of pipe line to install, cost is commonly a primary consideration. For a sound decision, other factors besides the cost must be considered, and particularly is this true of the factor of discharge capacity. The question which calls loudest for an answer from the point of view of sound economics is, Which pipe line of a safe and enduring character will cost the least per million gallons of discharge capacity at a time in the future when the maximum discharge capacity becomes of greatest importance?

One must therefore consider what the probable discharge capacity of different kinds of pipe lines will be when new and when old. The common expectation of a diminishing capacity in pipe lines of iron or steel has already been referred to. Certain considerations have likewise been presented in an earlier part of this paper, tending to show that a high-grade concrete pipe line with a hard, smooth interior surface has a high discharge coefficient and retains it through lapse of time.

The best evidence as to the average experience in the reduction of capacity of cast-iron and steel pipe lines is to be found in the Williams-Hazen hydraulic tables. A diagram is presented herewith to illustrate this point (Fig. 12). The coefficients and the discharge capacities for metal

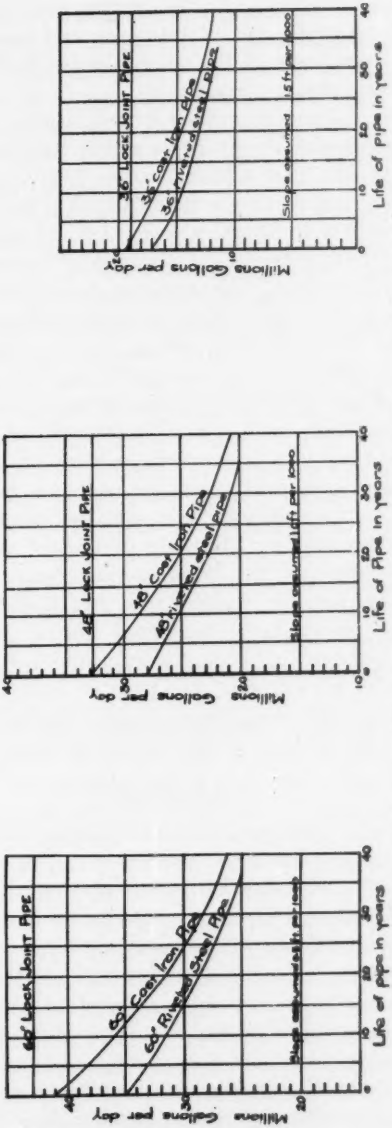

66" Lock Joint Pipe
66" Cast Iron Pipe
66" Riveted Steel Pipe
Slope assumed 1 ft per 1000
Millions Gallons per day
Life of pipe in years
46" Lock Joint Pipe
46" Cast Iron Pipe
46" Riveted steel pipe
Slope assumed 1 ft per 1000
Millions Gallons per day
Life of Pipe in years
36" Lock Joint Pipe
36" cast Iron Pipe
36" Riveted Steel Pipe
Slope assumed 1 ft per 1000
Millions Gallons per day
Life of pipe in years

FIG. 12.—RELATIVE CARRYING CAPACITIES OF LOCK JOINT, CAST-IRON AND RIVETED STEEL PIPE.

pipe are taken from the average experience indicated in the tables just referred to. The coefficient for high-grade reinforced concrete pipe lines is taken as 135, and a reference to the tabular statement of coefficients given by Scobey in an earlier part of this paper, and a consideration of the high quality and smoothness of the interior surfaces of Lock Joint pipe lines, shows that this value is conservative.

A study of this diagram cannot fail to make it clear that a high-grade reinforced concrete pressure line for water-supply will have a substantially greater carrying capacity after a term of years than pipe lines with metal surfaces subject to corrosion and incrustation. Precise comparison of course cannot be made as to future capacity of metal pipe lines. Likewise a generalization as to the coefficient of discharge of concrete pipe cannot be given a precise interpretation. Nevertheless, the broad interpretation of these general data is clear, and points to the importance of setting forth the best available information regarding probable corrosion, probable rate of change of carrying capacity, and probable future carrying capacity of different kinds of pipe lines under consideration at some point fifteen or twenty years in the future, with a view to determining what the relative costs of the several kinds of pipe lines will probably be, per million gallons of capacity, at that future time when the maximum rate of flow will be demanded. It is pertinent to state here that this basis of comparison of bids has already been applied. The city of Denver recently awarded a contract for a concrete pipe line, 66-in. in diameter and about six miles long. The bid presented for concrete pipe was higher than for certain others, but when known local experience as to corrosion and diminution of capacity of metal pipes was applied to the consideration of the bids, it was clear that the cost of the concrete pipe line, per million gallons carrying capacity at a time ten, fifteen or twenty years in the future, would be substantially less than the cost per million gallons for the metal lines.

JUSTIFICATION.

An article which possesses as many desirable features as the high quality reinforced concrete pressure pipe which can be made today, must merit the most careful consideration on the part of engineers and waterworks officials. By way of résumé, the degree in which these desirable features have been established will be briefly set forth.

The large carrying capacity of well-made reinforced concrete pipe lines is well established by the formidable array of data presented by Scobey in Bulletin 852, Bureau of Public Roads. Some of the data which he presents show also that concrete pipe lines, with good interior surfaces, retain their high carrying capacity during their first few years of service — the very time when large metal pipe lines commonly show the maximum rate of decrease in carrying capacity. The latest and best methods of manufacture, and the results they produce in dense, hard, smooth interior surfaces of perfect shape and alignment, and the inherent freedom of such

surfaces from the effects of corrosion, amply corroborate the few figures available on this point, and support the conclusion that high-grade concrete pipe lines do retain their high carrying capacity.

A sufficient quantity of this pipe has been in constant use over a long period of years to establish every indication of a life sufficiently long to warrant it in being classed among permanent materials. In France, Belgium, and England there are about five hundred miles of large reinforced concrete pressure pipes in use, dating back to 1892, and under pressures running up to more than four hundred feet. None of these lines has been abandoned, nor have they given any trouble. The city of Paris, for instance, started using this pipe in 1893 and the results of their initial installation have caused them to build many more similar lines. The experience in this country, where reinforced concrete pipe lines have been built with expansion joints, has been uniformly good, and several cities which have used it have placed repeat orders.

The joints, which are the crux of the whole proposition, have proven themselves to be the equal of any joint now in use. Of the types of joints under discussion, it is a fact that less than one-fifteenth of one per cent. of all of them installed by Lock Joint Pipe Company over the past nine years have necessitated any repairs of any nature whatsoever; and inasmuch as these joints run into the thousands, this would seem to establish the sufficiency of them.

A low limit of leakage, a desideratum of utmost importance, has been well established as attainable in every case where right methods are used. The actual measured tests already referred to have consistently shown that the loss of water from leakage is well within the present water-works practice.

The economy of good reinforced concrete pipe lines has been fully established in the minds of many users. They are low in first cost, frequently lower than large metal pipes, even when considered on the conventional basis of equal carrying capacities and equal diameters. But, if considered as they should be, in terms of the cost per million gallons of carrying capacity, when the pipe has reached an age of ten or twenty years, a high-grade reinforced concrete pipe line will commonly be found to involve the lowest cost. To this may be added the point that maintenance costs on these concrete pipe lines are practically nil.

It is worth while, too, to call attention to another important advantage which such concrete pipe lines possess. They do not rupture and cause large loss of water, flooding of streets and cellars, and interruption of service. Ruptures of pipe of more brittle material are not uncommon, and cause the more or less serious troubles just enumerated. The conditions which commonly cause such ruptures do not rupture a good reinforced concrete pipe line. The worst that can happen is for the steel reinforcing to be stretched sufficiently to cause fine cracks to develop in the concrete but without any actual rupture. This behavior has been noted repeatedly

under stresses far in excess of those for which the pipe was designed. It has been observed, too, that the fine cracks which open up in the concrete under such excessive stresses show a tendency to close up and become quite dry again within a short time.

Any article possessing permanent characteristics, a large working capacity, and an economical cost is well worthy of serious consideration.

Discussion.

Mr. Arthur E. Blackmer.* The town of Plymouth has used steel pipe, cement lined, since 1855. The present pipe has a steel shell, standard length 9 ft., with a cement lining about one-half to three-quarters of an inch in thickness, and an outside coating of about the same thickness. We make the pipe in our shop, the sizes from 6 in. to 18 in. We are now installing about one thousand feet of 14-in. between our pumping station and reservoir.

Mr. Francis T. Kemble.† There is one question I would like to ask the speaker. He stated that his pipe allowed a fracture. It seems to me that under certain conditions — for instance, settlement or possible frost conditions — you might get a break. Isn't that possible? If so, how can you repair it?

Colonel Longley. In reference to that: first of all, let me distinguish between pipe lines as they are commonly used for distribution systems, and pipe lines in country districts, — long supply lines. I am not sure that I made it clear, but I would like to, that concrete pipe lines of this class are adaptable primarily to long supply lines. That, of course, excepts such pipe as Mr. Blackmer has just referred to. Plymouth and various other Eastern cities have long used pipe of that kind, and have found it admirably adapted to use in distribution systems by the introduction of suitable connecting fixtures.

The point I want to make is, that in laying pipe lines across country we — I am speaking now as representative of the Lock Joint Pipe Co. — always do the excavation and the back-filling of the lines ourselves. Of all things, we are more particular about our foundation work than almost any other feature of the job, — the preparation of the trench and back-filling, — because we realize the importance of avoiding to the last degree the very things that you suggest. I do not recall now having heard of any experience that we have had with any pipe lines involving a fracture due to settlement, or to frost, or to earth pockets, or anything like that in the trench. Undoubtedly such a thing might conceivably happen, but the repair of damages of that sort does not appear to involve any serious difficulties.

The condition I had in mind, though, when I referred to the fracture of pipe and to the safety of reinforced concrete pipe against fracture, I

* Superintendent, Water Works, Plymouth, Mass.
† Secretary, New Rochelle Water Co., New Rochelle, N. Y.

can perhaps best explain by describing a test which was made some months ago, at the time of the American Water Works Convention in New York in May. It was made in our yard at Ampere, N. J. We had two sections of cylinder pipe put together with bulkheads at the outer ends so that the two formed a single barrel. The steel of those pipes was designed for an internal pressure of 150 lbs. per sq. in., which is a higher pressure, I might say, than any pipe which we have actually built. There was a water connection to the local mains, with a pressure of about one hundred and ten pounds, and also a small duplex pump by means of which the pressure could be run up to several hundred pounds.

A number of gentlemen came over from the Convention headquarters in New York City one day and we put the pressure up to 150, 175, 200, 225, 250, and up to 300 lbs. Unfortunately, our gage read only 300 lbs., so that we don't know just what happened beyond that point; but up to and approaching 300 lbs. we were unable to detect any leakage from the pipe or from the joints, or any physical distress in the pipe due to this high pressure. After the gage passed the 300-lb. mark we kept putting up the pressure with the duplex pump, and at some pressure in excess of 300 lbs. the exterior surface of concrete began to show cracks. When it began to show cracks, the cracks appeared quite numerous within just a few moments over an area of perhaps two or three sq. ft., showing that something had given way under that excessive stress. Now then, as near as we can figure, the unit stress on the steel at the time when visible distress began to show was something between 24 000 and 30 000 lbs. per sq. in. You would expect something to happen at that point, of course. But the interesting point of it all was that the pipe did not open up and let out any water. There was a little seepage of water through it, to be sure, where one of the welded joints of the steel cylinder had opened up under this extreme stress, and there was also a loosening of the exterior surface of the concrete outside of the outer cage of steel bars which surrounds the steel cylinder at a distance of about one and one-half inches from the outer surface of the pipe.

Now, at the appearance of this failure, as you might call it, or, this visible distress on the outside under excessive internal pressure, we cut the pressure down to the pressure of the city mains at that point, which was something like 110 lbs., and then we took cold chisels and hammers and went at the outside of the pipe, chopped away at it until we had exposed perhaps three or four sq. ft. of the outer surface of the reinforcement, and removed the concrete wherever it was loose. All this time the pipe was carrying water under 110 lbs., and carried this pressure and higher pressures for many weeks after the test. This showed in a striking manner that a reinforced concrete pipe line of this sort will still work as an effective carrier of water though such a fracture had occurred in the pipe.

Mr. Kemble. Have you had any experience with electrolysis on your reinforcement? Under some conditions that would give trouble, would it not? It is a matter for consideration, it seems to me. If something

went wrong and you had to repair the pipe you would be using more or less of a makeshift. Almost any repair, it seems to me, would be a makeshift if your reinforcement went — if you had a settlement of 5 ft., had a flood, or anything of that kind.

COLONEL LONGLEY. If any such cataclysm as that occurred, which resulted in the complete tearing away of a section of a pipe line, it would have to be rebuilt.

MR. KEMBLE. You would have to recast, wouldn't you?

COLONEL LONGLEY. Possibly, though not necessarily. It is quite possible that if a huge settlement occurred which permitted a break of this sort in a pipe line, it might come apart at the joints without any rupture of the pipe itself. I even have a favorable idea that that is just what would happen. Where pipes do come apart at the joints they can be refitted with a gasket and put right back in the line. If a serious settlement or washing-out occurs, one would naturally expect to have to do more or less extensive reconstruction work to put it together again.

As to electrolysis, we have had no experience with that whatever. We have done more or less speculating on that point, but have never been faced with a case of destruction or damage to pipe due to action of that sort.

SELLING.

Some Aspects of Selling, from the Manufacturers' and Purchasers' Viewpoints.

BY W. P. MOSTELLER.*

[*Read October 2, 1924.*]

When your Committee first suggested that they would like to have me present a paper at this Convention, setting forth some viewpoints of the manufacturer, it occurred to me that a few remarks on a subject we are all interested in would best serve our purposes.

We are all salesmen, whether we are in front of the desk or behind it, and we are all on a common footing. Therefore, I offer for your consideration some aspects of selling which I think touch both the maker and the consumer. The thought was suggested from the fact that the first questions asked when I visit users of cast-iron pipe, whether he be engineer, water-works superintendent, or water commissioner, are: " How is business, and what is the price of pipe? " We are all selling our services to the public in one form or another. The public is the final boss, whether the boss is the voter or a board of directors. Goods are as necessary to life as ideas and ideals, and everyone who seeks to bend opinion toward his own views — whether he be a theologian or a politician, a moralist or a scientist— employs the art of salesmanship. We have recently witnessed the concerted action of various trade organizations in cities throughout New England to bring to the fore merchandise made in the New England States, — a worthy and necessary thing to do if home industry is to be fostered. " Faith without works is dead," and the things which man neglects are bound to perish. The thing which survives and thrives is that to which he gives constant attention. No matter how necessary the article is, it takes the push of a resourceful salesman to convert it into cash, which, after all, keeps the ball rolling.

I shall not in this brief paper try to lay down any hard and fast rules for selling or purchasing. I couldn't if I tried. What I say shall be some of my observations of men and conditions as I have met them, and most of the things I have observed you have also observed, and know already.

We all know that a salesman must be optimistic. Optimism is *the* thing, and a man once said he *was* always optimistic, for he could see how much better it was for the world that men remember they are to " *practice* what they *preach* " rather then " *preach* what they *practice* " — the latter might set some bad examples.

* Of United States Cast Iron Pipe & Foundry Co.

The questions I have stated as the ones generally propounded show what is uppermost in the minds of men who are buying a product essential to the extension of a water-works system. I believe all salesmen welcome these questions, for they open a subject in which both are vitally interested. They also convey to the salesman's mind the probability of an active inquiry and a possible sale — which is stimulating, to say the least. Such questioning also shows that the prospective customer is interested in our particular product, that he is a careful buyer as well, and that he is looking for the best product he can obtain for the least money. My observation and experience with purchasers is that the careful buyer is always the best man to tie up to in the long run. He is always willing to talk over the matter, and will inquire into your methods of manufacture, the quality of the product you are offering, the rate of manufacture, facilities for shipping, the kind of service you can offer and are willing to give. You may depend upon it that this type of buyer will investigate on his part the facts that interest him, and if he is convinced that he will be well taken care of, he becomes a satisfied customer; which is, or should be, the objective point of all responsible manufacturers. Such a customer, if secured, is often willing to concede that the best is the cheapest, and the popular slogan will recur to his mind that " Service and quality are remembered long after the price is forgotten."

It would be a fine thing if all buyers could visit the plants of the various manufacturers from whom they purchase material. It would be a liberal education to many, and would establish a friendly and closer relationship, which would be invaluable to both buyer and seller. I believe strongly in the personal equation and personal contact, and you will recall that Charles Lamb once said, " You couldn't hate a man if you knew him."

Another benefit of a visit by the buyer to the plant of the maker would be to show the time required to get out the finished product. This knowledge would be helpful and cut out a lot of friction in times like these when we are not able to accumulate a large stock to ship from, and would also help users of material to realize the value of anticipating their requirements, and thus give the manufacturers an opportunity to make up the finished product in time for its actual need. It is neither safe, nor economical, to make up, in quantities, a product like ours, which depends upon a sensitive market like pig iron for its basic price; and if municipalities could anticipate their needs farther ahead, we could in turn anticipate our requirements for raw materials and, by buying on the markets at the right time, reduce our costs and selling prices accordingly.

A salesman has always a double service to perform, — a service to his employer and a service to his customer. Personally, I do not consider a sale consummated until the goods are delivered in first-class shape, and the customer happy and satisfied. That is the only way to pyramid your business. " Great trees from little acorns grow " is a truism we all know by heart; and may I not suggest another? — " Great orders from little services grow."

In selling, it is most essential to know your product, and know it well, for nothing begets substantial confidence like a display of knowledge of one's subject; but it is also the prerequisite of a successful salesman to see the other fellow's viewpoint; and what is success, after all, but common sense, and hard work, and getting down to brass tacks, — as so admirably expressed by our President and by General Dawes.

No order is too small to command careful attention, for everything purchased is bought because it is needed for a specific purpose. May I illustrate this by telling of an incident I witnessed one morning going into Boston on a Pullman car? I saw a man who had lost a shoe string — probably the most insignificant thing about his apparel, but at that time in his life the most important. He was upset. In fact, the whole car was in an uproar, and the man himself dejected and helpless. (I wondered what would have happened to his wife and children if he had been at home!) I have since heard that during the World War we took the shoe strings and suspender buttons from German prisoners as a method of keeping them in hastily constructed corrals. If you don't believe this is effective, cut your shoe strings and take off your suspender buttons, and try to run. A shoe string! Insignificant and inexpensive, but very important when needed; and salesmen will do well to remember this occurrence, as I have done for many years with profit. The bigger things are not being put across because we are not doing our part in the smaller things.

There are many kinds of salesmen but, fortunately for members of this Association, the ones you meet are specialists, and represent responsible concerns making standard goods, and offering high-class material and clean competition. The funny fellows — the ones the jokes of the humorists are leveled at — are not found here. If you desire to get a slant at some of the other type, I recommend Professor Leacock's latest book, "Garden of Folly." The salesman you meet here is not simply a door-knocker; he is a modern salesman, and is a gentleman representing a legitimate business house. He is trained in higher salesmanship, which requires that each sale shall *profit* both buyer and seller.

President Coolidge has recently well said on this subject: "Formerly there was a curious notion that if one side in a business transaction profited, the other must necessarily lose. If that were true, all business would be suspicious, and wise people would stand aloof from it. The truth is that when two parties enter into a transaction by which *each exchanges* something which he needs for something he needs *more*, both sides are benefited. That is the ideal basis of all trade and commerce and it is the real basis of most transactions."

The salesman comes to you with a carefully-thought-out proposition well worth an executive's careful consideration. Instead of being a time-waster, he is a time-*saver*, and a conveyor of much useful knowledge of business and market conditions. Cultivate him, and ask him questions about the things you want to know, and if he is not well informed, the first

visit, he will be the next time. When buyer and seller get together in this fashion, there will be a more cordial relation, better products, and better business.

May I not say a word here for the honest purposes of the manufacturer? He *is* honest, using every legitimate means at his command to produce a product of value; and the modern captain of industry realizes that honesty is as necessary as money to business. As a keen student of the methods which have developed big business in our country, he knows that permanent success has never come to a producer, or nation, guilty of dishonest commercial methods. Honesty is a necessity. Cutting corners, and sharp practices, bring no final rewards, and the success of manufacturers in this generation is based on an honorable attitude toward their obligations to their customers. Without honesty, business cannot expand, nor credit freely circulate. Public esteem, built upon honesty and goods of quality, is worth any manufacturer's ceaseless efforts to acquire.

The economic success of our country owes its development in large measure to *management*, and without this factor further progress cannot be made; for honest management is one of the constituent elements of a successful business. Let us, therefore, in passing, give full credit to the managers of our manufacturing plants, who keep us busy and offer employment to men and produce the articles we require.

Advertising is another important method of selling; and may I suggest that, since manufacturers are offering their goods through this medium, it will be well worth your time to read advertisements? I find it both profitable and entertaining to read these carefully prepared copies; profitable, because I learn of the new products on the market as well as keep up with the old; entertaining, because the copies have been prepared by the brightest minds of our country, carefully trained to express in words of the highest degree of excellence all that may be said to make converts for the cause of the goods or services or ideas advertised. Advertising is an art, and the preparation of the copy requires research and concentration of thought. If we understand literature as written expression in its most appropriate form, then advertising is entitled to its place in the literary sun. The advertisement of goods in its best sense is therefore important to mankind. I am often surprised to see so many unopened magazines lying about offices I enter, and I want to make a confession: I have taken the wrappers from many of these trade journals and opened them at some article or advertisement pertinent to the times, so that they would be seen and the valuable information noted, and not consigned to the waste-basket, unread. The advertisement is the silent salesman, to be taken up at one's pleasure, and it brings us a specially prepared message. Include it in your daily reading, and you will find that reading advertisements is profitable and instructive.

May I illustrate this point also, by telling you of another experience? The Philadelphia *Ledger* has an excellent business sheet which is issued

as a part of its regular edition, and one morning a gentleman sat with me on the train, and said that he had noticed I regularly read the business supplement, and he assumed, from my interest in the advertisements, that I was connected with a bond or banking establishment. I informed him that I was not, but that I read all the advertisements to get the news of what was going on in the investment world; to see where the money was flowing, and what sort of industries were expanding and needed capital for development. I showed him how well written they were, and suggested that it would be profitable for him to read them. Some months after our first meeting, this gentleman approached me and said that he had been following advertisements of public utilities and had made some sound investments as a result, and now he was passing the suggestion along to his friends to read advertisements.

I said at the outset of this paper that as purchasers you were also salesmen. That sounds paradoxical, but it is true, nevertheless. You can sell your personality to the salesman as easily as he can gain your confidence. Remember that we are all human, and if the milk of human kindness flows freely it is fattening. Fair treatment will be returned in like manner, and the application of the Golden Rule has never been misplaced.

And now, having delivered myself of a few of my observations and experiences in meeting and dealing with my fellow man, I want to answer briefly the two questions I stated were usually asked, viz., How is business? and What is the price of pipe?

Business in our line is good, and is improving. To say that business is good or that business is poor, is to make a statement that is all too general to mean very much. There are occasional boom periods when virtually all lines of business activity are yielding good profits; and, on the other hand, there are times when almost all business is up to normal. Such periods, however, are rare. It usually is more correct to sum up the situation by saying that some business is good, some is fair, and some is poor. Certainly, present business conditions must be described with qualifications. In general, trade is and has been quite satisfactory all the year. From trade reports it is evident that many lines of manufacturing have suffered from overproduction. The public has been consuming goods at or near a normal rate, but it has refused to buy in anticipation of its needs, being convinced that no shortages were likely in any lines. Meanwhile, the factories have been compelled to reduce output until surplus stocks could be liquidated. With a few exceptions, this process appears to have been completed, and production now is running along at a rate much closer to current consumption. The steel industry, for instance, is meeting with a gradually increasing demand, stocks in consumers' hands being low. Rubber also is beginning to improve as demands for tires and rubber products show signs of expansion. Demands for textiles, copper, etc., are increasing, and the automobile industry is far from the point of saturation. Railroads, which are always a big factor in our industrial life, are now buying more

freely. Pig iron prices are stiffening, and all metals are on the upturn, and stand to gain further as European demands come into the market on the settlement of the Reparations question. Secretary of the Treasury, Mellon, said recently: "I feel that the Dawes Plan will be a success and that we will shortly see established in Europe financial and commercial order. The industries of the countries, now a large part idle, will come into production, and the buying power of Europe, generally, will be enormously increased. This will mean more trade, in which we, as well as Europe, will share." Agriculture is already feeling the effects of higher prices for corn, wheat, and oats, and industries that depend primarily upon farm buying are improving. The outlook generally is much improved, and prospects point to prosperous conditions. The extensive and intensive building program still continues in many sections of the country, and this program, of course, creates a demand for water and gas pipes, hydrants, valves, meters, and other kindred lines. This abnormal demand has kept our foundries going along in good shape, and has given us three productive years.

During the past ten years, boundaries of prices have been changed, as well as the boundaries of nations; and a new price history will have to be written. The price of our product has advanced along with other commodities; but, when the ultimate cost of cast-iron pipe is considered, it is, and has always been, the cheapest product on the market; and if it could speak to you from the trenches tonight, where it has lain for a hundred years perhaps, and even longer, it would bear testimony to that fact. I wonder if you think sufficiently of its old and honorable record of service!

If you have followed the fluctuations of the markets, you have found that the prices of pipe have followed closely the rise and fall of pig iron and other raw materials, in conjunction with the high labor costs. One must always remember that cast-iron pipe is made by hand throughout, — from the core to inspection, — and that it has had, therefore, to stand the additional costs of higher-priced labor, with its proverbial decrease in individual daily output, which have run up costs to an unheard-of standard. Pipe prices have been dropping since early in the year, consistent with safe business conditions; and while it is hard to predict the future course of prices, the general trend is ultimately, we believe, toward lower levels. I say this in the face of the fact that very recent market letters from British and European bankers, as well as our own well-known statistician, Mr. Babson, and the Harvard Bureau of Business Administration, predict a period of higher prices for all commodities. This inflation may be only temporary, but authorities on this subject seem more than ever convinced that inflation is inevitable and that it is simply a question of the limits within which it can be kept. British bankers — so a recent report reads — take the view that it "is amazing how the subject of approaching inflation has been kept in the background in the United States."

We are living in a new era, and on a higher scale all along the line than

ever before in the world's history. We are demanding more luxuries, regardless of costs, — better things and bigger things. Our expenses for public improvements are enormous, — which include highways, public buildings, and civic improvements. Government expenses are high, consequently taxes are mounting; railroads must have high freight and passenger rates, which affect all commodities; our rates of wages must constantly be increased to meet new demands for household necessities. The waste of the World War must be paid for before we can hope to return to normalcy. We have progressed a step in our economic life, and my limited study of the world's business history leads me to the conclusion that we are going to maintain our present standards for a long time.

Will you permit me to say, in closing, that I like my work among you? I have always met with fair play and good will, and have had full consideration given to every proposition I have presented. I am sure I express the sentiment of the entire selling fraternity when I say that that is the unanimous thought of all the men I know. We are keen rivals for business, but friends under the skin, and enjoy meeting with you and your Water Boards to present our bids for your requirements. If we are not successful, we depart without rancor, knowing full well we have had our day at court and fair treatment. I have yet to hear of a single exception to this rule, and if our bids are rejected we leave, wishing you good luck and hoping to be the winner the next time.

THE LUXURIES OF YESTERDAY ARE THE NECESSITIES OF TODAY.

BY C. C. BEHNEY.*

(*Read October 2, 1924.*)

The luxuries of yesterday are the necessities of today. This may well be regarded as a statement of economic fact, and it applies equally to water-works activities as it does to every walk of life. The significance of this fact is reflected by the rapid development of products and devices for the water works, the increasing demand for the product, and the increased scope of its application. Instead of it being the luxury for the few, it soon becomes the necessity for all.

This transition from luxuries to necessities is a mark of progress, an economical advancement, and a healthy growth that is inevitable. Things that we did not need yesterday, we cannot afford to be without today. With the modern water-works plant there are so many factors of economy and service, that the necessities are numerous, and we cannot afford to be without them, because to do so we would not be operating efficiently or giving the required service which the public has a right to demand.

The increasing cost of supplying pure water, and the need for conserving water, have made necessary the use of many new devices, notably labor-saving and cost-saving devices. It has encouraged the use of many meters — meters at the source of supply and meters at the points of delivery — the consumers. Where yesterday we had one meter at the source of the distribution system and a few on the large consumers, today we have large meters to measure the water before and after filtering, a meter to measure the filter wash water, a meter on the discharge of each pump, and meters on every consumer.

Tomorrow we will also have meters or provisions for metering at strategic points throughout the distribution system, so as to establish a closer guard and to enable waste and leakage to be detected and isolated immediately. A number of the European cities are doing this today. Some of our American cities periodically make a water-waste survey which proves very profitable to them. In such cases the Pitot Tube recording meters and instruments for intensifying sound play an important and useful function. Since waste and leakages are costly factors with which every water works has to contend more or less, it follows that such and other measures should and will be taken by all water works to reduce waste.

Meters and instruments of precision that are now used by the larger companies will be required by even the smallest companies in the future.

*Of Simplex Valve and Meter Co., Philadelphia, Pa.

Without indicating and recording instruments to give valuable information for efficient operation, a plant is much like an army without an intelligence department, working in the dark, with attending big losses and sacrifices. Perhaps this is why some men say they can judge a plant by the instruments and products used. Engineers recognize these elements when designing water-works plants. They are governed principally by the necessity of the equipment, its useful functions and economies.

Accordingly, along with the boilers we have pressure gages, thermometers, draft gages, recorders, feed-water meters, and labor-saving devices. Along with the pumps are pressure gages, meters, and speed indicators. Along with the filters we have rate-of-flow controllers, to maintain the proper, steady flow for best results and bacterial efficiency; elevation gages; loss-of-head and rate-of-flow gages, for assistance and guidance in operation; hydraulic valves for saving time and labor; and in the larger plants master controllers for the same reason.

In the natural course of developments there always comes a demand for more automatic devices, and a demand for a given device to perform new and additional functions. Thus in some cases the rate controller is called upon, not only to regulate the flow at a constant rate, but also to automatically change that rate when certain conditions prevail — for example, to automatically reduce the flow when the water in the clear well reaches a certain elevation, and to close when another elevation is reached. Such automatic devices and instruments for efficient and intelligent operation are not only labor-saving or cost-saving, but sometimes also enable direct savings in other items of initial cost so as to reduce the total expenditure.

When putting meters on all consumers cuts down the pumpage 25 or 50 per cent., as it has in numerous cases; when instruments of precision answer so many questions of vital importance and are means for bringing the efficiency of operation up to its maximum; and when labor-saving devices and water-waste surveys save more than they cost, then they are necessities. They are things we cannot afford to be without.

And these are but a few examples that confront such a growing and complex concern as a water works.

If we are confronted with seeming luxuries today, it follows that they will be necessities tomorrow.

At a new and modern water-works plant it was observed that at first the operators regarded the equipment of automatic devices and instruments as so many unnecessary luxuries which only added to their daily duties, and that, on the other hand, they soon regarded them as their faithful servants necessary for efficient operation. The transition from luxuries to necessities is rapid with individuals when the usefulness of a thing is an experienced fact.

The operators and the engineers of water works set the standard and the demand for the necessary products and the service required of them,

and the manufacturers welcome their criticisms and suggestions. They earnestly strive to give good service, and products of quality that will fill the needs, effect economies, and give the user the satisfaction and the pleasure of a luxury.

Consider such a universally used product as the gate valve: how today its use is found necessary at practically every street intersection instead of at widely scattered points.

WATERPROOFING WALTHAM'S (MASS.) CONCRETE STANDPIPE.

BY GEORGE C. BREHM.*

[*Read October 8, 1924.*]

In 1906 the City of Waltham, Mass., constructed a reinforced concrete standpipe, which was at that time the largest of its type in the country. The writer will not at this time attempt to go into great detail as to the construction of this tank because it was most fully described in the JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION in December, 1907, by Bertram Brewer. I will, however, review certain phases of the construction, especially as to the great care exercised in preparing the concrete in order to insure a water-tight job.

The standpipe was constructed of 1–2–4 concrete, the wall being reinforced with steel bars arranged in three rows up to 20 ft., two rows for the next 17 ft., and one row to the top, same being designed to keep the tensile stress within a 12 000-lb. limit. The roof consists of a concrete slab 3 in. thick, supported by steel trusses radiating from a central concrete-covered pipe column, which serves also as an overflow.

This standpipe is 100 ft. in diameter, 43 ft. high, with capacity of a little over 2 million gal. of water, and is situated in the western end of the city on a ledge knoll, the original cost being about $26,000. The specifications for this contract were prepared with the greatest care; the engineers in charge did everything possible to produce a concrete which would be absolutely water-tight. Every precaution known at the time was taken to insure against the slightest seepage.

After extensive experiments it was decided to add to the concrete hydrated lime to the extent of five per cent. of the weight of the cement.

Where one day's work joined another, special precautions were taken, the old surface being cleaned with steel brushes down to hard material. The old concrete was then thoroughly wet down and neat cement grout brushed in and the new concrete added before the grout had time to set. As an additional precaution for securing a good bond, a groove at least 4 in. deep and 3 in. wide was constructed in the top portion of the wall and allowed to stand and set.

The forms were removed as soon as possible and the inside of the wall was treated as follows:

All loose and unset material was removed from the surface, special care being given to the joints in cleaning them thoroughly and jointing with neat cement. The wall for a distance of 9 ft. up was plastered with a mix-

* City Engineer and Director, Department of Public Works, Waltham, Mass.

ture of one of cement and three of sand, with the addition of hydrated lime to the extent of 10 per cent. and Medusa compound to the extent of 3 per cent. of the weight of the cement.

The remainder of the wall was cleaned and jointed as above, and two thin coats of cement grout, consisting of a mixture of three parts of cement to two parts of sand, and Medusa compound to the extent of five per cent.

WALTHAM STANDPIPE.

of the weight of cement, were brushed in thoroughly, taking special care of the joints.

In spite of all of these precautions at the time of construction, leakage developed after a few years, causing disintegration and spalling of concrete. In 1913 an ill-advised attempt was made at waterproofing by the application of a coat of pitch to the inside wall. This amounted to very little, and another attempt was made during the winter of 1915–1916 and the summer of 1917 by the application of cement, using a cement gun, on the outside; but neither of these methods proved satisfactory. The seepage continued

and successive frost action caused several large areas of the outside wall to disintegrate and spall off, the surface breaking in several places to such an extent that the reinforcing rods became slightly exposed at several spots.

The water level of this standpipe, when full, is 256 ft. above sea level. The city also has, adjacent to this standpipe, an open reserve reservoir with a capacity of 6 million gal., the elevation being, when filled, approximately 205 ft. above sea level. Between the year 1913, when the first attempt was made at waterproofing, and the present time, the water system of the city has been extended to the developed outlying sections, and at the present time requires a head of not less than 235 ft. at all times for the convenience and safety of the whole city, especially the outlying sections.

In 1922, when the writer attempted the waterproofing of this standpipe, the problem confronting the city was to keep sufficient pressure to insure the convenience and safety of the whole city with its water supply while a thorough and final job of waterproofing was being done. It was obvious that the reserve reservoir at an elevation of 205 ft. would not insure the supply.

The idea was conceived of erecting an 8-in. pipe in the vicinity of this standpipe, tapping the 24-in. feeding main with a 24-in. x 8-in. Smith tapping sleeve and valve, and by keeping the pumps continuously operating, maintaining a head of water at all times at sufficient height to insure the city supply. A wrought-iron 8-in. pipe was therefore erected to a height of 276 ft. above sea level, and the pumps operated continuously for 24 hours per day, the speed of the pumps being regulated to maintain enough pressure to drive the water to the top of this pipe sufficiently to have a slight overflow, the pipe being erected so as to allow this overflow spill to drop into the open reservoir.

The contract for waterproofing having been previously let and all details arranged, the large concrete standpipe was emptied, the inside wall thoroughly cleaned and dried, a number of salamanders being used to hasten the drying. After the walls were thoroughly dried, the waterproofing was started. It consisted, first, of a mop coat of Texaco No. 56 waterproofing material, applied hot to the inside face of the wall. Immediately on this was applied a coat of waterproofing felt, the surface of the same being mopped with another coat of Texaco No. 56 waterproofing asphalt. This operation was repeated for five layers, the outside layer, however, being of 6-oz. saturated duck fabric, and the outside surface of this finally mopped with the waterproofing asphalt. Immediately following this a 4-in. brick core was constructed from the floor to the top of the wall, great care being taken to obtain a $\frac{1}{2}$-in. mortar course between the outside asphalt course and the inside face of the brickwork. All of this work, of course, was started at the bottom and built up the entire inside circumference of the wall in 6-ft. sections.

The work was started November 20, in spite of the most inclement weather, and was finally completed and the reservoir refilled on December

23. As the stagings on the side of the wall were taken down, the whole inside face of the brick core was thoroughly cleaned by washing.

It is of interest to note that all the materials used in this work had to be hauled to the very inaccessible point where the reservoir is located, raised to the top and lowered through a 4-ft. hole made in the concrete roof. Instead of the usual steam or electric power for hoisting, the contractor used a medium-sized tractor, rigging a boom derrick on the top of the reservoir, fastening the hoisting-cable to the front of the tractor, which raised and lowered all the materials in a hoisting-pan in this manner.

Simpson Brothers of Boston were the general contractors on the work, W. A. Murtfeldt Company of Boston, subcontractor on the waterproofing, and M. F. Stankard of Waltham, subcontractor on the brickwork. The engineer's estimate on the whole work was $16 500, while the low bid of the contractor for the whole work was $16 543. The materials used in the work were about as follows:

15 tons of Texaco waterproofing asphalt,
150 rolls of felt,
550 bags of cement,
100 bags of lime,
85 000 brick.

About two years have elapsed since the reservoir has been refilled and every indication shows that a complete waterproofing job has been accomplished and that no further seepage is visible.

The entire outside surface of the reservoir has been thoroughly patched where disintegration has taken place and the whole outside surface will be given a thin stucco finish for the sake of appearances in the near future.

PROCEEDINGS.

The following is a synopsis of such parts of the proceedings at the Rochester convention as appears to be of value for the record.

Forty-Third Annual Convention.

Rochester, N. Y.,
September 30, October 1, 2, 3, 1924.

The Forty-Third Annual Convention of the New England Water Works Association was held at Rochester, N. Y., September 30, October 1, 2, and 3, 1924.

The sessions of the Convention were held at the Powers Hotel, where also were provided accommodations for the exhibits of Associates.

The Convention was called to order on September 30, 1924, at 10.00 A.M. by David A. Heffernan, the President, who introduced Mr. Beekman C. Little, Superintendent, Bureau of Water, Rochester, N. Y.

Mr. Beekman C. Little. Ladies and gentlemen of the New England Water Works Association: I think most of you know how glad all of us in the Water Works Bureau of Rochester are to have you here, because I have personally told a great many of you. We certainly are glad to welcome you to our city.

It gives me a great deal of pleasure to introduce Hon. Clarence D. Van Zandt, Mayor of Rochester.

Address of Welcome by Honorable Clarence D. Van Zandt, Mayor, City of Rochester.

Mayor Van Zandt. Ladies and gentlemen: I am more than glad to welcome you to Rochester. I am certain also that your deliberations here will — in fact, must — result in some good not only to Rochester but to the country.

They used to tell me in school that about two-thirds of the earth's surface was covered with water. However, there is only a small portion of that which is potable and, at the rate the water bureau is increasing, it seems that if something is not done we shall have to do away with prohibition or the people will die of thirst. (*Laughter.*)

I am quite sure you must have brought this weather with you, because you are so interested in water. You picked out about the two worst days we have had in the entire season, and we have had plenty of rain at that.

I do not know how long you are going to be here. Perhaps most of you have been here before. But I am certainly sorry that you cannot see Rochester under good weather conditions and see what a beautiful place

it is. Every Convention that we have here brings some more people to live in Rochester. They look around and very quickly make up their minds that this is just about the best place in the country, and they are anxious to come here to live; and some of them do.

You have some very serious problems to consider; we have them in Rochester. We need additional water supply, and it is very hard today for some of the cities to get good water and in sufficient quantities without too great an expense. We cannot spend money like New York City does. We have got Lake Ontario; but people seem to be prejudiced against Lake Ontario. I cannot imagine why, unless it is because some of this water comes down past Buffalo. We are today looking for a further water supply. Mr. Little can tell you a great deal more about that than I can. I do not pretend to give expert advice on any subject outside of my own. I was brought up in the drug business and I can make good pills. (*Laughter.*)

But there is something that I do know, and that is that you gentlemen are all working along the lines of proper, healthful supplies of water for our big cities. And, as I said before, it is certainly growing to be more serious all the time, and I hope we are going to derive some benefit in Rochester from your visit here and your deliberations.

I thank you. (*Applause.*)

Response by President Heffernan.

The President. Your Honor, Mayor Van Zandt, let me express, on behalf of the New England Water Works Association, my deep appreciation of your hearty welcome to Rochester. This is one of the few times we have gone outside the section from which we have taken our name, and it is the second time we have come to Rochester, so it must be apparent to you that your city has some attraction for us.

It is with pleasant memories that we look back to 1910 when as a body we were here before, and it is with anticipated pleasure that we look forward to our visit here.

You know we members from Massachusetts, especially, have a personal interest — I might say physical interest — in Rochester. We like your city so well that we might take some of it away from you; or, at least, the Attorney-General of Massachusetts is bending his efforts in that direction, so although you probably do not feel highly complimented by his action, it at least shows an appreciation of what you have. And I know that although we may not take home with us your water-front land, I am sure, in view of your cordial welcome, we will return with pleasant memories of our visit.

I thank you. (*Applause.*)

Mayor Van Zandt. I will add just a word. Of course down in Massachusetts you do want our lake shore front, because it is so much better than anything you have in Massachusetts. But we are not going

to let you take it away, no matter how much we have to pay to keep it. (*Laughter.*)

A paper on The Water Supply and Other Interesting Engineering Features of Rochester, prepared by Edwin A. Fisher, Consulting Engineer, Rochester, N. Y., was read by John F. Skinner, Deputy City Engineer of Rochester.

The paper was followed by an address by the retiring President who spoke as follows:

(*Address of Retiring President Heffernan.*)

Our Forty-Third Annual Convention has opened in this very-much-alive City of Rochester. It is here that something in the nature of an experiment is being made in the prevention of goitre by treating the drinking water with sodium iodide, — an experiment the results of which are being anxiously awaited by doctors, boards of health and water-works men. If successful, the world will owe a debt of gratitude to this city.

Rochester is very much to the fore; it is growing, its progressiveness is of the safe and sane sort, and its citizens are justly proud of its achievements and boost their city by word and act. We, as members of the New England Water Works Association, have pride in what our organization has done in the past and we expect that it will continue to preserve its entity and force in the water-works field. But let us take pattern by the citizens of our convention city and shove it ahead by working for it. It is only through the coöperation of the individual members that our Association can be improved and strengthened, and, in my opinion, it is the presentation of papers which, more than any other one thing, contributes to our progress.

In the course of the year many papers, instructive and interesting, were read before the Association and printed in the JOURNAL. A considerable portion of the President's time is consumed in making arrangements for papers. It is my belief that this work might better be handled by someone outside the presidency. I would suggest that another office be created which would be responsible for this duty.

To my mind, the papers which are read at the meetings and collected in the JOURNAL cement the members together more completely than anything else. It is hard for me to imagine us getting together monthly for the purposes of eating and jollification. A more serious bond must keep us united; and this is found in the illuminating papers which are presented at our gatherings.

It was a source of great disappointment to me when I attempted to obtain papers from the superintendents. Their lack of interest was a sign of danger. To begin with, I sent out a letter to a considerable number of members requesting that they prepare a paper on some topic of interest, leaving the subject to be of their own choosing. The replies were, almost without exception, from engineers.

Now, this Association is composed of two classes of men,—superintendents and engineers. The reason for their coalition is that they are necessary to one another. This is as it should be. A combination of the two in one man is ideal but rare. And I want to say now to the superintendents, that if we do not take a more active interest in its affairs the Association will keep slipping till it is over the brink. We are gainers by our membership through the knowledge we obtain, by what we learn of others' experiences, the difficulties they encounter, and how they overcome them. And I earnestly ask that you take these words, not as advice, — which often passes unheeded, — but as a warning. It is much easier to keep an old organization in repair than to build a new one.

In the last few years the course of my work on committees and in offices of the Association has occasioned my visiting a number of water works. In many of the smaller places the conditions surprised me. There was nothing palpably wrong, but they were old-fashioned. Now, the art of being old-fashioned lies in being just enough that way so that someone else does the experimenting, and when it is proven successful you step in. If, instead of becoming a success, it is a fizzle, you stay just where you were; you wasted no money and you have the satisfaction of knowing that you benefited by being old-fashioned. But don't be out-of-date. In some places the superintendents were doing things in the same way they had been done 25 years ago. I asked one man why he continued in the same manner. He told me that was the reason why — simply because it had always been done that way. I tried to have him join the Association. He said he did not have time to attend the meetings. Another would not join because it cost him too much to ride back and forth. If the governing body directing the efforts of the superintendent could be made to realize the benefits to be obtained by membership in the Association, I feel sure they would see that their superintendent had the time to attend the meetings, and his expense money, too. But it leads us back to where we started. We must have more papers from superintendents, — papers telling of practical experiences.

Tell us about how you coöperate with your fire department. Do you ask the advice of the fire chief as to the location of hydrants? Do you receive hydrant rental, and, if so, on what is the charge based? Do you make periodical inspections during the freezing weather, or is this left to the fire department? If you maintain them, how do you keep the surface water out, or, if you do not try to, how do you prevent them from freezing? Do you make a point of inspecting hydrants after fires? —if your relations with that department are so amicable that they are not interesting, or so disagreeable that you cannot talk about them without the use of profanity, take some other subject. Tell us about the tools, appliances, or accessories that have made your work better or easier.

Do you use a service-box finder? Have you any means of determining the location of a pipe if your plans are old or incorrect? Have you a good

instrument for finding leaks? Do you use a tapping machine for branches, or do you still shut down and " break out " ? Have you a valve-inserting machine or, if it is too expensive, did you know it can be rented, together with the services of a competent man?

Have you studied—I want to emphasize that word—have you studied which material makes the best service pipe to carry the particular water you supply? If so, what are you using, and why?

Have you accounting methods for keeping your books, or do you still maintain a system based on a cash book?

Do you ask your superiors for some large extensions you feel are necessary to the system and, when refused, — because you were not able to make your point clear, — eat humble pie, or do you call in an engineer and have him put in words and figures what is in your mind?

Do you believe in town managers? No; I know you don't. Do you believe the water department should be combined with other town or city departments under a commissioner of public works? Do you consider purchasing agents assets to small municipalities? No? Well, tell us about it. If you have experienced any of these things, let us in on them. If you have guessed wrong, tell us, so that we shall not. If you have bought some instrument or piece of machinery which is saving time and money for you, pass your knowledge around. Remember that very few of the things we know were the result of our own experience. By far the greater part of our knowledge developed from what someone told us or what we read somewhere. Loosen up — let others know what you know and then come here and learn what others have to tell you.

Standing out prominently in my recollection of the activities of the Association in late years are the names of five men, — Walker, Gow, Stacey, Coggeshall and Martin. Those of us who have fulfilled our duties as members or, at least, followed the progress of the Association, realize the debt of gratitude we owe the memory of these superintendents. They were practical men who were not afraid to speak out loud, — men who, though busy in their own departments, found or made time to work for our good.

I know we have the ability among our superintendents to carry on the work these men and their associates began; and I earnestly ask of you not to permit your modesty to keep you and your knowledge in the background. During the coming year many of you will be requested to prepare a little talk. Do not refuse the new president as you denied me.

We, collectively, are the Association. Its success is dependent upon our efforts. Its achievements are a benefit to us directly.

In compliance with the provisions of the Constitution in regard to the nomination and election of officers (Article VII, section 4), one hour after the opening of the Convention the President declared the polls closed and appointed Percy R. Sanders, George A. King, and George F. Merrill as a committee to open and count the ballots.

TUESDAY AFTERNOON, SEPTEMBER 30, 1924.

Award of Dexter Brackett Memorial Medal.

THE PRESIDENT. The first part of the program this afternoon will be the award of the Dexter Brackett Memorial Medal.

On September 13, 1916, this Association voted a fund which was to perpetuate the name and memory of an eminent engineer, a past president of our Association, the late Dexter Brackett.

It was considered that the best form of memorial would be a medal, to be offered each year for the most meritorious paper read before the Association by a member, bearing in mind its applicability to general water-works problems.

At this time I will call upon Mr. Francis T. Kemble who, as Chairman of the Committee, will make the award for the Association. (*Applause.*)

MR. FRANCIS T. KEMBLE. Mr. President and gentlemen: Your committee, after carefully considering all papers, many of which had much merit, have selected the paper on Rapid Sand Filtration, read by Col. George A. Johnson, — I do not remember the date exactly, — as the one for which we recommend the award of this medal. The paper in question was of interest to all classes of water companies.

COL. GEORGE A. JOHNSON. Mr. President, Mr. Kemble, and gentlemen: When I received the first intelligence of the award of this much-coveted honor it was indeed a great surprise, and consequently, perhaps, even more appreciated than it otherwise might have been. Any man who has been fortunate enough to become the recipient of this medal, endowed by one of our greatest water-works engineers, has just right to be proud, and I am today proud indeed to be its recipient.

Nevertheless, I feel that the acceptance of this medal must carry with it an acknowledgment on my part that the credit for whatever worthiness attaches to the paper I prepared must in large part be bestowed upon those who so courteously and ably contributed to the discussion of the paper, and to those officers of this Association who so ably prepared it for publication. In their names and in my own I accept this medal with a feeling of great gratification, because it comes to me at an hour when I can perhaps appreciate it more than I ever could again. A lot of you gentlemen do not realize, I believe, that, although I live in New York, I was born in Maine and fetched up, as we say, in Massachusetts; consequently, I am a Yankee.

This honor is one which I shall ever cherish, and this medal will remain one of my most valued possessions, forever. (*Applause.*)

Mr. John F. Skinner, Deputy City Engineer, Rochester, N. Y., read a paper on A Description of our Reservoirs and Gravity Conduit Lines.

A paper entitled The Syracuse (N. Y.) Water Supply was read by Marshall B. Palmer, Engineer of Water Bureau, Syracuse, N. Y.

Mr. Stephen B. Storey, Director, Bureau of Municipal Research, Rochester, N. Y., read a paper on Rochester's Meter Reading and Billing System. Messrs. W. C. Hawley, Beekman C. Little, W. L. Hatch, J. Walter Ackerman, Frank E. Winsor, Stephen H. Taylor, George F. Merrill, and George C. Gensheimer took part in the discussion.

Election of Officers.

The committee appointed to open and count the ballots reported as follows:

President.

Stephen H. Taylor, Superintendent of Water Works, New Bedford, Mass..... 279

Vice President.

Frank E. Winsor, Chief Engineer, Water Supply Board, Providence, R. I..... 282

Directors.

James A. McMurry, Superintendent, Income and Meter Division, Boston Water Department, Boston, Mass..... 273

Arthur D. Weston, Principal Assistant Engineer, Massachusetts Department of Public Health, Boston, Mass..... 278

Treasurer.

Albert L. Sawyer, Water Registrar, Haverhill, Mass..... 276

The President. By report of your Committee you have elected the following officers for the ensuing year: President, Stephen H. Taylor; Vice-President, Frank E. Winsor; Directors, James A. McMurry and Arthur D. Weston; Treasurer, Albert L. Sawyer.

It would give us great pleasure at this time to hear from our President-elect, Mr. Stephen H. Taylor.

Mr. Stephen H. Taylor. Mr. President and gentlemen of the New England Water Works Association: When Mr. Sherman rang me up on the telephone and said that I had received the call by the Nominating Committee, the story crossed my mind of the Irishman who lived some distance from the railroad station and who had to take a very early train one day, driving some distance, so that he went to the city the night before and tried to get a room at the hotel, and was told that the only available bed in the hotel was in a double room, one bed of which was occupied by a colored person. He did not just like the idea of sleeping in the same room with a colored person, but it was a case of doing that or sleeping on the grass in cold weather; so he took the only choice he had. Some of his friends also went to town to see him off, and when he got soundly asleep they thought they would have some fun with him, so they blacked his face. In the morning he got his call, which he had left with the bell-boy for a certain time, and between the time he was called and the time his train went, which was very limited, he simply got into his clothes and rushed

to the station. The ticket-seller looked at him and smiled, and most everybody that saw him looked and smiled. Bye and bye he asked someone what the joke was — what everybody was laughing at. One man said, "You go and look in the mirror"; which he did, and saw that his face was well blacked up. Remembering that he had slept in the room with a colored man, he said, "By Gorry, that darned bell-hop has called the wrong man!" (*Laughter.*)

I feel very much afraid that the Committee has called the wrong man. But seriously, gentlemen, I appreciate the honor that has been conferred upon me by this nomination and election, and will do the very best I can to fill the office. I also appreciate that considerable hard work and responsibility goes with the honor, which I will do my best to carry on. I am going to ask the coöperation of every member of the Association, active and associate, because I realize that it is beyond my powers, or the powers of any other man, to conduct the affairs of the Association without considerable help.

I do not know that I have anything further to say now except to again thank you all for the honor conferred. (*Applause.*)

Wednesday Morning, October 1, 1924.

Mr. Charles B. Burdick, Consulting Engineer, Chicago, Ill., read a paper on Infiltration Galleries at the Des Moines Water Works.

Col. Francis F. Longley of the Lock Joint Pipe Company, Ampere, N. J., read a paper on Reinforced Concrete Pipe for Water Supply Lines under Pressure. Messrs. Arthur E. Blackmer and Francis T. Kemble took part in the discussion.

Wednesday Afternoon, October 1, 1924.

A paper on Sand Spun Pipe was read by Mr. Charles R. Wood. The discussion was participated in by President Heffernan, Caleb M. Saville, Charles W. Sherman, William R. Conard, R. C. Wheeler, and Frank A. Barbour.

Mr. Charles A. Holmquist, Director, Division of Sanitation, New York State Department of Health, read a paper on The Relation of Improvements in Public Water Supplies to Typhoid Fever and Other Intestinal Diseases. The paper was discussed by Mr. Henry A. Symonds.

A paper on Present Methods of Water Purification in Providence, prepared by Julius W. Bugbee, City Chemist, Providence, R. I., was read, in the absence of Mr. Bugbee, by Mr. Frank E. Winsor. Messrs. Harry C. Kerr and E. T. Cranch took part in the discussion.

A paper on Chlorine in the Treatment of Respiratory Diseases was read by Mr. M. F. Tiernan, President, Wallace & Tiernan, Inc., Newark, N. J. Messrs. Charles W. Sherman and Frank C. Kimball took part in the discussion.

Mr. W. M. Beisel, Chief Engineer, Pottsville Water Company, Pottsville, Pa., read a paper on The Indian Creek Dam of the Pottsville Water Company. The paper was discussed by Mr. Frank E. Winsor.

WEDNESDAY EVENING, OCTOBER 1, 1924.

Mr. V. Bernard Siems, Water Engineer, Baltimore, Md., read a paper on The Establishment of a Metropolitan District in Baltimore County Contiguous to Baltimore City.

Mr. Caleb Mills Saville, Manager and Chief Engineer, Board of Water Commissions, Hartford, Conn., read a paper on Floods and Droughts on New England Streams.

In the absence of Mr. Chester M. Everett, Consulting Engineer of New York City, who was scheduled to present a paper on The Deisel Engine Installation at New Britain, Conn., Mr. F. H. Hayes gave his experiences with the Deisel Engine.

THURSDAY, OCTOBER 2, 1924.

Through the courtesy of the Water Works Manufacturers Association the members of the New England Water Works Association and their guests left Rochester at 9.30 A.M. by special train to Niagara Falls. Upon arrival, luncheon was served at the Temperance Hotel, after which the party spent the afternoon in seeing the sights of the place and visiting the industrial and power plants; also the municipal water works and filtration plant. The return to Rochester was made by special train leaving Niagara Falls at about 4 P.M.

THURSDAY EVENING, OCTOBER 2, 1924.

A paper on Selling; some Aspects of Selling from the Manufacturers' and Purchasers' Point of View, was read by Mr. W. P. Mosteller of the United States Cast Iron Pipe and Foundry Company.

A paper on The Luxuries of Yesterday Are the Necessities of Today, was read by Mr. C. C. Behney of the Simplex Valve and Meter Company, Philadelphia, Pa.

The Secretary and Treasurer, Frank J. Gifford, submitted his annual reports. (*See pages 311-316.*)

The Auditing Committee reported as follows:

REPORT OF THE AUDITING COMMITTEE.

September 26, 1924.

We have examined the accounts of the Secretary and Treasurer of the New England Water Works Association, and find the books correctly kept and the various expenditures of the past year supported by duly approved vouchers. The Treasurer has also accounted to us for the investments and cash on hand, as submitted in the above report.

FRANK A. MARSTON,
GEORGE A. SAMPSON,
SAMUEL E. KILLAM,
Finance Committee.

The Editor of the JOURNAL, John P. Wentworth, submitted his annual report. (*See pages 317-319.*)

On motion of Mr. George A. King, duly seconded, it was voted that the foregoing reports be accepted and placed on file.

The apparent decrease in membership during the past year, as indicated by the Secretary's report, brought up the subject of possible ways of stimulating interest in the Association and increasing its membership. Percy R. Sanders, President Heffernan, Secretary Gifford, W. C. Hawley, Frank A. Barbour, George A. King, and Arthur D. Weston took part in the discussion.

FRIDAY, OCTOBER 3, 1924.

Superintendents' Day.

Mr. William R. Conard, Consulting Engineer, Burlington, N. J., read a paper on Large and Small Fire Hose, Water Pressures and Hydrant Spacings. Messrs. R. H. Lockwood, Percy R. Sanders, Harry A. Burnham, Beekman C. Little, Patrick Gear, Theodore L. Bristol, and Edward D. Eldredge participated in the discussion.

A paper on Teaching an Old Dog New Tricks was read by Mr. Payne Dean, of Payne Dean, Ltd., Stamford, Conn.

FRIDAY AFTERNOON, OCTOBER 3, 1924.

A paper on Increase of Available Water Supply With No Capital Expenditure, prepared by Mr. F. E. Beck, Engineer, Consolidated Water Company, Utica, N. Y., was read, in the absence of Mr. Beck, by Mr. Charles W. Sherman.

Mr. Charles S. Beaudry of Lexington, Mass., read a paper on Waterproofing a Leaking Standpipe. The discussion was participated in by Messrs. John P. Wentworth, Charles W. Sherman, Frank J. Gifford, M. N. Baker, and L. M. Hastings.

Mr. George C. Brehm, City Engineer and Director, Department of Public Works, Waltham, Mass., read a paper on Waterproofing Waltham's Concrete Standpipe.

MR. JOHN P. WENTWORTH. I would like to offer the following resolution:

That the thanks of the New England Water Works Association are hereby extended to the Hon. Clarence D. Van Zandt, Mayor of Rochester; to the Public Works Department and the Bureau of Municipal Research, and to the other officials and employees of the City of Rochester; to the members of the Honorary Reception Committee; to the Local Committee of Arrangements; to the Ladies' Committee, and to the non-members who have so kindly presented papers.

(The motion was duly seconded and unanimously carried.)

MR. M. N. BAKER. Mr. Chairman, I have another resolution I would like to offer:

Resolved, that the thanks of the New England Water Works Association be extended to the Water Works Manufacturers Association and to the Committee which has contributed so much to the success of the Forty-Third Annual Convention.

(The motion was duly seconded and unanimously carried.)

PRESIDENT HEFFERNAN. We are now closing the Forty-Third Annual Convention of the Association and I want to take this opportunity to thank the officers and members for their hearty support, making it possible for me to carry out successfully the business of this Association during my term of office, which terminates at the close of this session. To the new officers I extend best wishes for a happy and successful year.

(*Adjourned.*)

ANNUAL REPORT OF THE SECRETARY.

Mr. President and Gentlemen of the New England Water Works Association,—The Secretary submits herewith the following report of the changes in membership during the past fiscal year, and the general condition of the Association.

The present membership is 758, constituted as follows: 9 Honorary, 665 Members, 2 Juniors, 81 Associates and 1 Corporate Member, there being a net loss for the year of 11. The detailed changes are as follows:

MEMBERSHIP.

September 1, 1923.	Honorary Members.....	9			
September 1, 1924.	Honorary Members.....				9
September 1, 1923.	Total Members.....		685		
	Withdrawals:				
	Resigned.....	18			
	Dropped.....	36			
	Died.....	12	66	619	
	Elected:				
	September.....	5			
	November.....	1			
	December.....	1			
	January.....	2			
	February.....	2			
	March.....	3			
	June.....	5	19		
	Reinstated:				
	Resigned in 1918.....	1			
	Dropped in 1918.....	3			
	Dropped in 1920.....	1			
	Dropped in 1921.....	1			
	Resigned in 1922.....	1			
	Dropped in 1923.....	20	27	46	
					665

September 1, 1923.	Total Juniors:				
	Elected:				
	December	1			
	March	1			
		—			2
September 1, 1923.	Total Associates		75		
	Withdrawals:				
	Resigned	3			
	Dropped	4	7	68	
		—	—		
	Elected:				
	September	6			
	November	1			
	February	1			
	June	1		9	
		—			
	Reinstated:				
	Dropped in 1923			4	81
				—	
September 1, 1923.	Total Corporate Members:				
	Elected:				
	September	1			1
					—
September 1, 1924.	Total membership				758
September 1, 1923.	Total membership				769
					—
	Net loss				11

Members Elected from September 1, 1923, to September 1, 1924.

September 19, 1923. J. W. Everett, C. C. Gerrish, J. O. Herr, F. B. Northrop, J. L. Purcell. (5)
November 13, 1923. Edward M. Craig, Jr. (1)
December 11, 1923. J. A. Foulks. (1)
January 8, 1924. Charles B. Cruger and Urban S. Lambert. (2)
February 2, 1924. Warren J. Scott and Gordon M. Fair. (2)
March 3, 1924. Julian P. Wood, George E. Bragg, and M. J. Rutledge. (3)
June 25, 1924. Edward A. Barrier, John H. Damon, F. Wellington Gilcreas, Thomas Henderson, and Ernest L. Sampson. (5)

Reinstated:

Resigned in 1918, Clinton S. Howe	1
Dropped in 1918, F. L. Andrews, E. M. Shedd and R. W. Wigmore	3
Dropped in 1920, J. F. O'Sullivan	1
Dropped in 1921, G. Ferullo	1
Resigned in 1922, E. H. Magoon	1
Dropped in 1923, G. L. Adams, C. S. Beaudry, C. A. Bingham, S. W. Borden, F. L. Cole, W. D. Fredericks, W. H. Jackson, H. C. Kinney, J. S. Langthorn, E. J. Looney, Henry Manley, L. P. Marshall, S. J. Mason, E. L. H. Meyer, C. W. Mille, F. H. Robbins, F. N. Strickland, D. H. Townley, Morrell Vrooman	20

Junior Members.

December 11, 1923, Elson T. Killam. (1)
March 3, 1924, Frederick O. A. Almquist. (1)

Associate Members.

September 19, 1923. Birch Mfg. Co.; W. G. Classon; Federal Meter Co.; General Chemical Co.; Resisto Pipe & Valve Co.; Pittsburgh-Des Moines Steel Co. (6)

November 13, 1923. The White Company. (1)

February 2, 1924. Fairbanks Morse & Co. (1)

June 25, 1924. Reading Iron Company. (1)

Reinstated:

Dropped in 1923. Allen & Reed Co., Inc.; American Manganese Co.; Lock Joint Pipe Co., and Roberts Filter Mfg. Co. (4)

Corporate Members.

September 19, 1923. New Britain Board of Water Commissioners. (1)

Members.

Died: L. M. Bancroft, C. S. Burns, H. E. Cushing, J. H. Dunlap, L. P. Hapgood, C. H. Johnson, Ransom Rowe, David Rundlett, W. H. Sawyer, J. C. Trautwine, Jr., G. L. Watters, and F. I. Winslow. (12)

Resigned: F. C. Beck, S. W. Borden, G. R. Ellis, R. F. Gadd, F. C. Gamwell, G. D. Jackson, W. E. Miller, S. E. Minor, C. H. Preston, E. L. Pride, T. W. Proctor, S. J. Scacciaferro, F. W. Scheidenhelm, J. F. Sharpe, Jr., R. H. Stearns, Morrell Vrooman, W. J. Willson, R. F. Bennett. (18)

Dropped: G. F. Ashton, Stephen Barden, Alex. Brest, A. T. Clark, B. S. Coleman, F. J. Dixon, H. W. Dotten, L. R. Dunn, A. J. Durst, H. T. Foley, W. D. Frederick, J. E. Gleason, H. E. Gabriels, F. H. Gunther, F. H. Hapgood, C. Nelson Harrub, W. H. Jackson, R. F. Johnson, A. F. Hart, P. E. Kelly, H. C. Kerr, H. C. Kinney, C. L. Kirk, C. W. Knight, W. T. Lenehan, S. J. Mason, J. A. McMurry, L. P. Marshall, C. W. Mills, E. E. Minor, J. D. Moore, H. Lester Newhall, W. G. Newhall, Alexander Potter, S. L. Ruggles, L. W. F. Carstein. (36)

Associate Members.

Resigned: American Manganese Bronze Co., Electro Bleaching Gas Co., and Merritt, Chapman & Scott Corporation. (3)

Dropped: Badger Meter Mfg. Co., Metalium Refining Co., New York Continental Jewell Filtration Co., and New England Oil Refining Company. (4)

Receipts for Fiscal Year, September 1, 1923, to September 1, 1924.

Initiation fees			$126.00
Annual Dues:			
Members	$2 708.81		
Juniors	3.00		
Associates	1 049.81		
Corporate	10.00		
		$3 771.62	
Fractional Dues:			
Members	$116.50		
Juniors	1.50		
Associates	48.65		
		166.65	
Past Dues		214.00	
Total Dues			4 152.27
Advertisements			2 835 00
Subscriptions			321.99
JOURNALS sold			241.25
Sundries			247.82
Total receipts			$7 924 33

There is due the Association:		
Advertisements	$707.00	
Standard Specifications	.75	
Subscriptions	144.00	
Total	$851.75	851.75
TOTAL		$8 776.08

Respectfully submitted,
FRANK J. GIFFORD, *Secretary.*

ANNUAL REPORT OF THE TREASURER.

September 1, 1923, to August 31, 1924.

CLASSIFICATION OF RECEIPTS AND EXPENDITURES.

Receipts.

Dividends and Interest		$327.15
Initiation fees	$126.00	
Dues	4 152.27	
		4 278.27
JOURNAL:		
Advertisements	$2 835.00	
Subscriptions	321.99	
JOURNALS sold	241.25	
Sale of Reprints	44.35	
Meter Specifications	104.60	
		3 547.19
Miscellaneous:		
List of members	$3.00	
Exchange	.50	
Meter rate sheets	1.63	
Membership buttons	3.75	
Standard specifications	7.50	
Certificates	4.50	
		20.88
Total receipts		$8 173.49

Expenditures.

JOURNAL:		
Advertising agent's commission	$261.25	
Plates	374.28	
Printing	3 064.79	
Editor's salary	300.00	
Editor's expense	16.75	
Reporting	250.92	
Reprints	396.01	
Stationery and postage	119.60	
		$4 783.60

Office:		
Secretary's salary	$200.00	
Secretary's expense	105.60	
Printing, Stationery, and Postage	117.52	
Membership Lists	260.70	
Affiliated Technical Societies	1 964.75	
Incidentals	44.29	
		2 692.86
Meetings and Committees:		
Stereopticon	$50.00	
Dinners for guests	18.00	
Music at dinners	16.50	
Printing, stationery, and postage	387.34	
Badges	71.11	
		542.95
Treasurer's salary and bond	$67.50	
Certificates of membership	6.50	
Exchange	.96	
Miscellaneous	145.99	
		220.95
Total expenditures		$8 240.36

Respectfully submitted,

FRANK J. GIFFORD, *Treasurer.*

TREASURER'S REPORT.

STATEMENT OF RECEIPTS AND EXPENDITURES.

Receipts.		*Expenditures.*	
Cash on hand Sept. 1, 1923	$9 329.71	Bills paid as per vouchers	$8 240.36
Interest on bonds and deposits	327.15	Cash on hand	9 262.84
Received from Secretary	7 846 34		
	$17 503.20		$17 503.20

ASSETS AND LIABILITIES.

Assets.			*Liabilities.*	
Cash in Banks as per list		$7 447.84	Surplus	10 114.59
Old Colony Tr. Co.	640.41			
Home Savings Bank	1 011.25			
Franklin Sav. Bk.	2 000.00			
Farmers & Mechanics Savings, Framingham	2 068.46			
Mechanics Sav. Bk., Reading	261.19			
Peoples Sav. Bk.	1 466.53			
Bonds Nos. 2642 and 2644, Lake Shore & Michigan R. R., 4s, due May 1, 1931		1 815.00		
Accounts Receivable		851.75		
Advertisements	707.00			
Standard Specifications	.75			
Subscriptions	144.00			
		$10 114.59		$10 114.59

Annual Report of the Editor.

To the New England Water Works Association: The Editor submits herewith the following report for the year ending August 31, 1924.

As has been customary in the past, the tables of financial figures, accompanying this report, are based upon total charges and accounts paid, or payable, rather than actual cash received or disbursed.

Table 1 is a statement of the material published.

Table 2 gives the receipts and expenditures for the year.

Table 3 is a comparison of the Journal for the past year with preceding years.

Size. The four issues contained 611 pages, of which 404 were text.

Cost. The gross cost of the Journal was $4 783.60, equivalent to $6.26 per member, and the net cost was $561.51, equivalent to $0.74 per member.

Reprints. Fifty reprints of each paper have been furnished to the author where desired.

Circulation. The present circulation of the Journal is:

Members, all grades	758
Subscribers	108
Exchanges	14
Total	880

(Journals have been sent to all subscribers.)

Advertisements. — During the early part of 1924, an effort was made to increase the amount of advertising. As a result, new contracts were signed, amounting to $688, most of which have two more issues to run. The net gain in advertising over the year 1922 was $267.

Respectfully submitted,
JOHN P. WENTWORTH, *Editor.*

EDITOR'S REPORT.

TABLE 1.

STATEMENT OF MATERIAL IN SEPTEMBER AND DECEMBER, 1923, AND MARCH AND JUNE, 1924, ISSUES OF THE JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

Date.	Pages of								
	Papers.	Proceedings.	Total Text.	Index.	Advertisements.	Cover and Contents.	Insert Plates.	Total.	Total Cuts.
September, 1923..	86	20	106	0	41	4	1	152	22
December, 1923..	94	3	97	4	41	4	5	151	18
March, 1924.....	93	9	102	0	45	4	3	154	24
June, 1924.....	95	4	99	0	49	4	2	154	6
Total.....	368	36	404	4	176	16	11	611	70

EDITOR'S REPORT.

TABLE 2.

RECEIPTS AND EXPENDITURES ON ACCOUNT OF SEPTEMBER AND DECEMBER, 1923, AND MARCH AND JUNE, 1924, ISSUES OF JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

Receipts.		*Expenditures.*	
Advertisements.....	$3 499.00	Advertising agents' salary and commissions.....	$261.25
Sale of JOURNALS.....	235.00	Plates.....	374.28
Reprints.....	30.10	Printing.....	3 064.79
Subscriptions.....	457.99	Reporting.....	250.92
	$4 222.09	Mailing, Postage.....	119.60
Net cost of JOURNAL.....	561.51	Editor's salary.....	300.00
		Editor's incidentals.....	16.75
		Reprints.....	396.01
	$4,783.60		$4 783.60

EDITOR'S REPORT.

TABLE 3.

COMPARISON OF JOURNALS OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

	Vol. XXVII. 1913.	Vol. XXVIII. 1914.	Vol. XXIX. 1915.	Vol. XXX. 1916.	Vol. XXXII. 1918.	Vol. XXXIII. 1919.	Vol. XXXIV. 1920.	Vol. XXXV. 1921.	Vol. XXXVI. 1922.	Fiscal Year Ending Aug. 31, 1924. 4 issues.
Average edition (copies printed)	1 000	1 050	1 325	1 500	1 388	1 200	1 150	1 100	1 100	1 100
Average membership	745	803	904	1 002	954	902	885	864	826	764
Circulation at end of year	858	951	1 079	1 155	1 010	1 002	970	929	929	880
Pages of text	554	564	596	538	398	566	359	399	618	404
Pages of text per 1 000 members	746	702	659	538	417	627	406	462	748	529
Total pages, all kinds	733	719	776	707	557	726	520	560	801	611
Total pages per 1 000 members	984	895	859	707	584	805	588	648	970	800
GROSS COST:										
Total	$3 586.29	$3 345.87	$4 243.35	$3 386.63	$3 115.00	$4 967.99	$5 011.03	$5 381.84	$6 354.10	$4 783.60
Per page	4.89	4.65	5.47	4.79	5.59	6.84	9.64	9.61	7.93	7.83
Per member	4.81	4.17	4.68	3.38	3.26	5.51	5.66	6.23	7.69	6.26
Per member per 1 000 pages	6.46	5.80	6.02	4.79	5.85	7.59	10.88	11.12	9.60	10.25
Per member per 1 000 pages text	8.68	7.39	7.85	6.30	8.19	9.74	15.77	15.61	12.47	15.50
NET COST:										
Total	$1 322.90	$1 155.33	$1 091.09	$1 171.98	$694.54	$2 675.04	$1 722.14	$1 869.85	$2 434.26	$561.51
Per page	.80	1.61	2.70	1.65	1.25	3.68	3.31	3.34	3.04	0.92
Per member	1.78	1.44	2.32	1.17	.73	2.97	1.95	2.16	2.95	0.74
Per member per 1 000 pages	2.42	2.00	2.98	1.65	1.31	4.09	3.75	3.87	3.68	1.20
Per member per 1 000 pages text	2.42	2.38	3.88	2.17	1.83	5.25	5.43	5.43	4.77	1.82

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Plans and Specifications for Textile and other Industrial Plants, Water Power and Steam Power Developments. Examinations and Reports on Plants with reference to their Value, Reorganization or Development.

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FRANK J. GIFFORD, *Sec'y*,
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$.75
Dear Sir: Enclosed please find 1.50 in payment of charge for Certificate
2.25
of Membership in the N. E. W. W. Association ($1.50), and Membership Button ($1.00), which please mail me and oblige

Yours truly,

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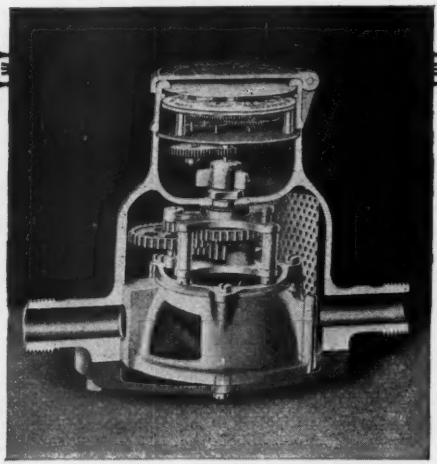
CONTRACTORS

G. FERULLO COMPANY
General Contractors
Specializing in Water Works
31 NORTH SQUARE
BOSTON, MASS.
Telephone, Richmond 1200

If this should happen to you



WATER REVENUE STIRS COUNCIL

Members Call on Curley for Accounting for Last Two Years

HEALEY WANTS LIGHT ON SEWER EXPENSES

City Councilman James T. Purcell introduced a resolution which was passed unanimously at the council meeting yesterday calling on Mayor Curley to furnish a detailed accounting of revenue derived from the water service in the two years of his administration to date. He [illegible] he explained, to force [illegible] water rates

POLITICAL attacks upon your stewardship of the Water Department's revenue can be met with perfect confidence if your service outlets are equipped with Hersey Water Meters.

Hersey Water Meters register accurately the tiniest dribble or the largest flow. This accuracy is considerably in excess of the requirements of the American and New England Water Works Associations, a fact which alone saves thousands of dollars annually.

Every year more Water Departments standardize on Hersey Meters because their quality is unexcelled — because they are an absolute safeguard of the Department's source of income.

6591

HERSEY Trade Mark WATER METERS

HERSEY Manufacturing Company

Main Office & Works: Corner E and 2nd Sts., South Boston, Mass.

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PHILADELPHIA, PA. ..... 314 Commercial Trust Bldg.
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ATLANTA, GA. ..... 610 Citizens & Southern Bank Bldg.
SAN FRANCISCO, CAL. ..... 742 Market Street
DALLAS, TEX. ..... 2301 Griffin Street
PORTLAND, ORE. ..... 403 Hoyt Street

FROZEN!—but not damaged

Here is an actual photograph of a LAMBERT Frost-proof Meter which has been frozen to an extent that would put the ordinary meter completely out of commission.

This is made possible by a patented, non-corrosive yielding bolt device which allows the upper and lower casing, disc chamber and gear train to part without damaging the meter in any way. Five minutes' labor the only repair cost.

The expense and annoyance from frozen water meters can be eliminated for all time through the installation of the LAMBERT Frost-proof.

It has been proved that the LAMBERT is the easiest water meter to take apart and put together again as well as the simplest, most reliable and accurate.

If you are interested in other types of meters, we make one for every requirement.

THOMSON METER COMPANY

100-110 BRIDGE STREET BROOKLYN, N. Y.

LAMBERT FROST-PROOF METERS

Five and a Half Million Dollars Saved

IT is a popular fallacy that water is free — free as air — or, at least, should be. That idea isn't much respected by the Municipal Engineer who has to plan reservoir, piping and pumping extensions to meet the requirements of a growing community. He knows that for every million gallons of daily water consumption there must be an investment of about $300,000. That fixed ratio of cost holds true whether the water is used for necessary purposes or whether it is wasted.

Atlanta, Georgia, was using water at the rate of 200 gallons per capita daily. Then meters were installed.

Today the daily per capita consumption is 80 gallons — a saving of 60 per cent. Five and a half million dollars is a conservative estimate of the investment which would be required to supply the additional 24,000,000 gallons saved by the installation of water meters.

Meters do not limit the legitimate use of water, but they stop water waste. They conserve the water resources of a community and increase storage in its relation to a given population. They actually reduce the cost of water and distribute that cost where it legitimately and fairly belongs.

AQUAFAX is a 64-page monthly magazine giving current news and accurate information regarding the conservation of water. The regular subscription price is $3.00 per year, but it will be sent free upon request to engineers, municipal heads and civic organizations.

PRIVATE water companies are dependent entirely upon the accuracy, the efficiency and the durability of the meters on their service lines. It is a significant fact that most of the private water companies in the country use the Neptune Trident Meter.

Send for a copy of the new 96-page booklet illustrating and describing all types and sizes of Neptune Trident Meters.

NEPTUNE METER COMPANY

Pioneers in Meter Progress

50 EAST FORTY-SECOND STREET, NEW YORK CITY

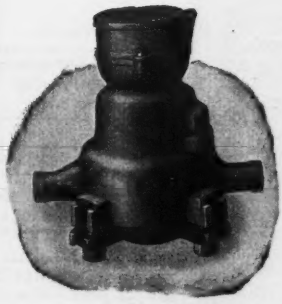
Neptune Meter Co., Ltd., 1197 King Street, West, Toronto, Ont.

Boston Chicago San Francisco Atlanta Los Angeles Seattle Portland St. Louis, Mo

WATER METERS

The TROPIC — An all-bronze Water Meter, with connection spuds attached to the lower case. Particularly designed for warm sections of the country.

TROPIC



ARCTIC

The ARCTIC — A frost-bottom meter, especially designed for cold sections of the country.

These two meters embody exactly the same mechanical features, the only difference being the changes necessary to provide a frost breaking feature in the Arctic.

Either of these meters will be equipped with a COMPLETELY ENCLOSED intermediate train RUNNING IN OIL, if desired.

Write or wire nearest office for full information.

Please Note Change of Address

PITTSBURGH METER COMPANY

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Seattle, 4038 Arcade Building
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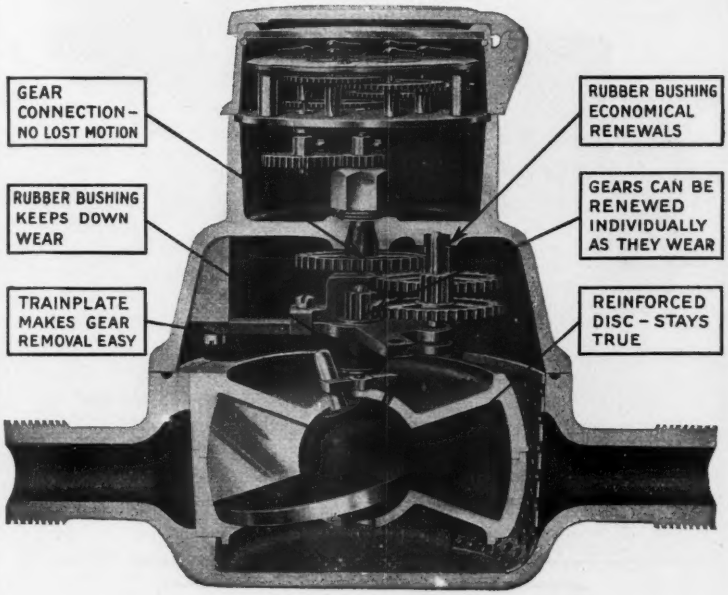
Worthington Meters


GEAR CONNECTION – NO LOST MOTION
RUBBER BUSHING KEEPS DOWN WEAR
TRAINPLATE MAKES GEAR REMOVAL EASY
RUBBER BUSHING ECONOMICAL RENEWALS
GEARS CAN BE RENEWED INDIVIDUALLY AS THEY WEAR
REINFORCED DISC – STAYS TRUE

WORTHINGTON PUMP & MACHINERY CORPORATION
115 BROADWAY, NEW YORK BRANCH OFFICES IN 24 LARGE CITIES

WORTHINGTON

This Year
The City of Rochester Welcomes
THE
New England Water Works Association

Fourteen years ago Rochester installed its first **Venturi Meters** (another product of New England), a 24-inch and 36-inch to measure the unusually excellent water supply obtained from Hemlock Lake.

In 1916 a 60-inch **Venturi** was added for sewage and **in 1917** a 30-inch for an additional main water line.

Wise planning for future growth requires Venturi guidance and dependability.

BUILDERS IRON FOUNDRY

Builders of the Venturi for 33 Years

PROVIDENCE, R. I.

AMERICAN AND NIAGARA WATER METERS

5/8 INCH NEW AMERICAN WATER METER

5/8 INCH NEW NIAGARA WATER METER

Niagara and American Meters are of the disc type. The Niagara Meter has a galvanized cast-iron outside casing; the American Meter has a bronze main casing with either a bronze base or a galvanized cast-iron base. The works in the three different casings are the same and interchangeable. Upon opening the meter at the bolted flange, each intermediate gear may be immediately removed from its bearing, the measuring chamber lifted from its seat, the strainer slipped out, or the register tried by turning the stuffing box gear. All submerged working bearings are protected against sand and sediment. The hard rubber measuring disc is reinforced with a metal plate. Purchaser has option of round reading or straight reading register indicating cubic feet, U. S. gals., imp. gals. or litres.

Round Reading Register

Straight Reading Register

BUFFALO METER CO.

ESTABLISHED 1892

2896 Main Street BUFFALO, N. Y.

The New Nilo

The new improved **Nilo Compound Meter** now comes equipped with a bronze body. This is a valuable addition to meter service for it eliminates the danger of corrosion and filling up due to the collecting of corrosive matter. Bronze being stronger than iron the gross weight of the meter is less, making it easier to transport, handle and install.

It also has two gate valves which allow the removal of the by-pass meter for cleaning or repairing without shutting off the line.

The controlling valve mechanism of the new **Nilo Compound Meter** is self contained and easily detached from the main body casings.

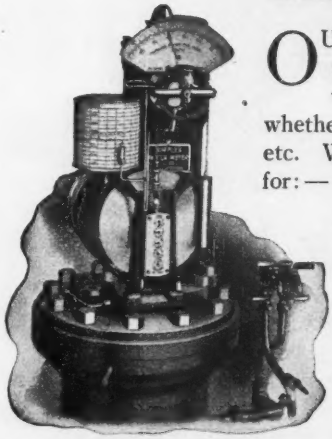
These three improvements make the **Nilo,** a long standing favorite, the unrivaled leader in its field.

UNION WATER METER CO.

Incorporated 1868

WORCESTER, MASSACHUSETTS

Is Your Pressure Low?
Are You Short on Pumping Capacity?
Do You Know Where Your Water Goes?



OUR Engineering Department will tell you how to determine your water distribution, how to find out whether or not new mains are required, etc. We can supply you with the means for: —

1. Checking up pump performance and determining slippage due to leaky plungers, defective valves, short stroking or other causes,
2. Measuring delivery of centrifugal pumps and figuring whether or not the station is up to efficiency,
3. Distributing proportionately the cost of water supplied to several districts,
4. Checking up the performance of filter beds,
5. Detecting waste or pipe leakage,
6. Recording daily amounts of sewage handled and planning future extensions, etc., etc.

THE SIMPLEX METER

VENTURI, PILOT TUBE OR ORIFICE TYPES

THE importance of exact measurements by means of a Simplex Meter cannot be over emphasized. Mr. Jeffries, Chairman of the West Chester, Pa. Water Works Committee, was able, by checking the performance of his pumping engine with a Simplex Meter, to discover that due to the imperfection and wear in the valves the slippage amounted to 300,000 gallons of water per day. This represented a daily loss of $30.00, or in other words a daily saving of $30.00, or $900.00 per month, when the valves were put in order. The Simplex Meter thus paid for itself in a month's time.

Frequent repeat orders from satisfied customers who formerly used other meters are the best evidence of merit of the Simplex Meter.

We have had many years' experience in solving water flow problems involving all sorts of conditions, and we are at all times prepared to submit general layouts involving cost and capacity, and to make explicit and complete recommendations. Write for Bulletin N26.

SIMPLEX VALVE AND METER COMPANY

Manufacturers of Meters for Water, Sewage, and Other Liquids, Rate Controllers, Automatic Air Valves, Regulating Valves, and Hydraulic Apparatus of Special Design.

5729 RACE STREET PHILADELPHIA, PA.

"WATCH DOG" WATER METERS

ACCURATE *DURABLE*

DISC, CURRENT AND COMPOUND TYPES

Inquiries Solicited

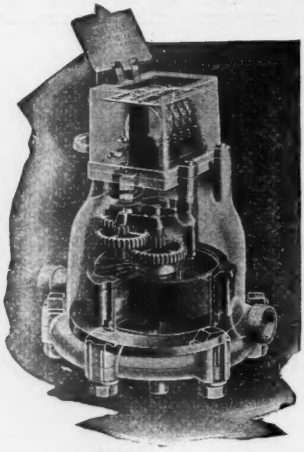
GAMON METER COMPANY

NEWARK NEW JERSEY

EMPIRE

OSCILLATING PISTON

WATER METERS



The EMPIRE has been on the market for forty years, and in all that time no other meter has ever equaled it for accuracy and endurance. That isn't a bad record to look into if the meter-buyer wants to get the most for his money; for when all's said and done it is the close registering meter that brings in the revenue, and it is the long wearing meter that keeps down expenses. A customer who recently gave us a nice order for EMPIRES told us that he did so because he had had about forty-five of them in service for sixteen years — all testing today up to standard — and in that whole time they had *never cost one cent for repairs.*

WHAT EMPIRES HAVE DONE FOR OTHERS THEY CAN DO FOR YOU

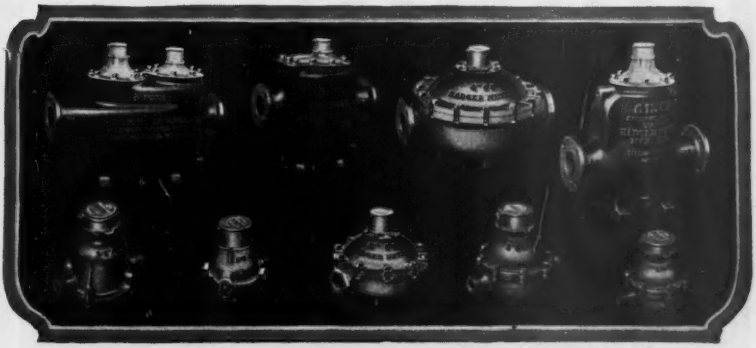
Don't take our bare word for it, — let us send you names of some towns using EMPIRE meters extensively, so you can do your own investigating.

EMPIRES are made in all sizes 5/8″ to 6″.

NATIONAL METER COMPANY

299 BROADWAY, NEW YORK

Chicago Boston Cincinnati Atlanta San Francisco Los Angeles



Make the Badger Meter your Standard for Comparison!

Just as you judge other equipment by standards — compare water meters with the Badger. Make it your **standard for comparison.** Point for point, base your rigid inspection on the outstanding construction advantages of the **Badger.** Be assured that the meter is **fit.** That it will **tick-off accurately.** That it will **register** an impartial tolling year after year. Don't accept less.

Badger Meters have long been highly reputed. Chiefly because they are built right. They are designed by practical water works engineers. All parts are readily accessible and made of such metals and materials that will not corrode, nor wear unduly. They are made for long life and service.

Let the Badger prove its dependability, accuracy and earning powers. Remember they are **faithful to the last drop.**

Write for special bulletins.

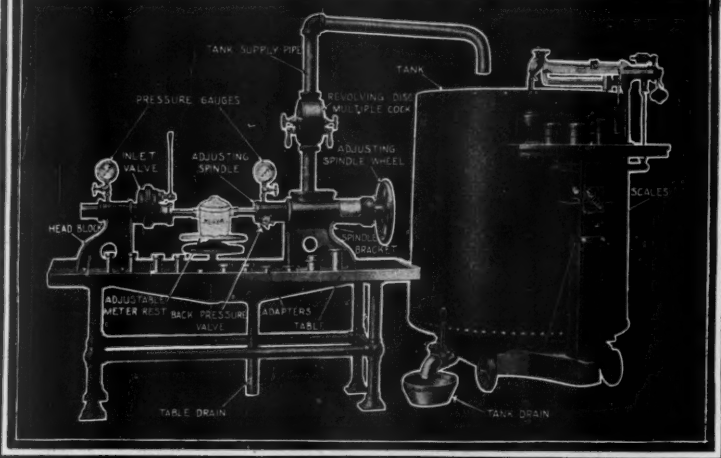
Badger Meter Manufacturing Company

Milwaukee, Wisconsin

111 W. Washington Street, Chicago, Ill. 32 Court Street, Brooklyn, N. Y.
414 Interstate Bldg., Kansas City, Mo. 1621-39 Fifteenth Street, Denver, Colo.

BADGER METERS

"Faithful to the last drop"



The People Demand Increased Efficiency

You can make sure your Department gets full revenue for every gallon of water used—by seeing that all meters are regularly tested for accuracy—with the

Mueller Water Meter Tester

The Mueller will prove exactly what each meter does—will enable you to adjust each meter to absolute accuracy—will save more than its cost year after year. Used and endorsed by leading municipalities. The name Mueller guarantees both Quality and Service.

Detailed description and prices on request.

MUELLER CO., Decatur, Illinois

Phone Bell 153—Auto 2131

Water, Plumbing and Gas Brass Goods

New York City, 145 W. 30th St. — Phone, Madison Square 5397

San Francisco, 589 Mission St. — Phone Sutter 3577

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ATTENTION
WATER WORKS
OF NEW ENGLAND

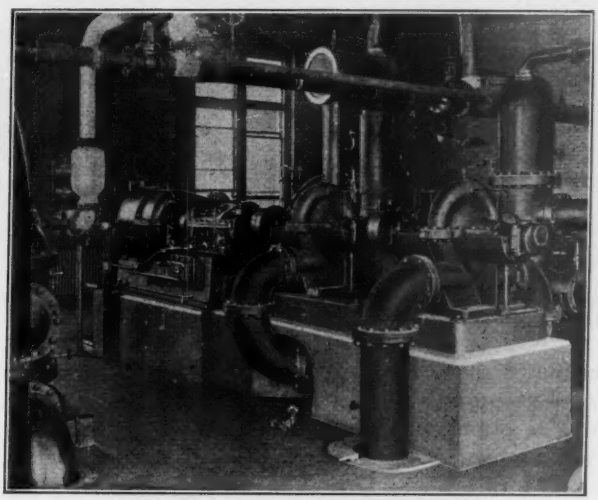
A few reasons why we solicit your inquiries on Water-Works Pumping Equipment:

First. — We make a specialty of furnishing Complete Water-Works Pumping Units of all types.

Second. — Total responsibility of installation is assumed by us.

Third. — We relieve the purchaser of every detail and turn the complete unit over to him under actual operation and with guarantee.

Fourth. — Every unit installed to date has exceeded its guarantee and has been completely accepted.



Turbine-driven Pump at the Arlington Station of the Metropolitan Water Works, Boston, Mass.

F. A. Mazzur & Co.

141 MILK STREET, BOSTON

Centrifugal Water Works Pumps

BUILT FOR THE LAST 70 YEARS AT BALDWINSVILLE, N.Y.

By Morris Machine Works

Reliable **Substantial** **Efficient**

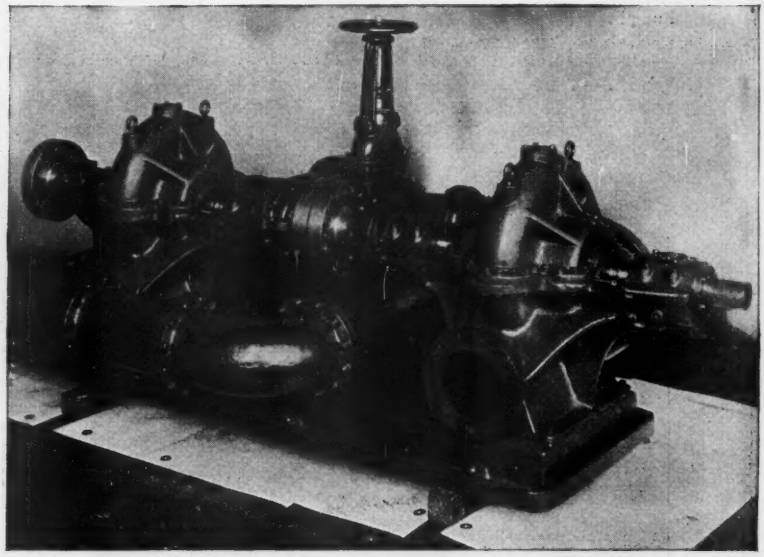


Illustration shows two 3 M.G.D. pumps just furnished as part of complete waterworks equipment to Kennebec Water District, Waterville, Me., to plans and specifications of Metcalf & Eddy, Consulting Engineers, Boston. These pumps will be driven by direct connected Motors and with Gasoline Engines for stand-by service. Arrangement permits single or series operation depending upon head, which varies greatly with capacity required.

We furnish pumps for all heads and capacities, motor turbine or engine driven, and when desired install complete units ready for operation.

Starkweather & Broadhurst, Inc.

ENGINEERS AND CONTRACTORS

79 Milk St., Boston

Phone, Congress 1810

"SERVICE BEFORE PROFIT"

HAYES PUMP AND MACHINERY CO.

94 PEARL ST., BOSTON, MASS.

Pumping Plant Contractors

CENTRIFUGAL, POWER, STEAM PUMPS

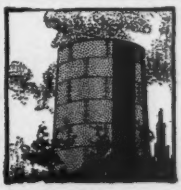
STEAM TURBINES
WATER WHEELS

ELECTRIC MOTORS
OIL ENGINES

RAY ENGINEERING COMPANY
136 FEDERAL STREET
Boston, Mass.

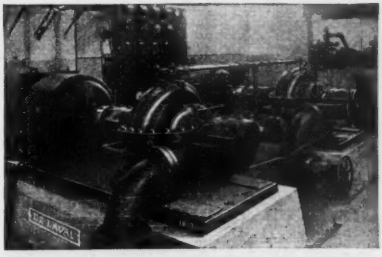
Power Plant Equipment
Steam and Heating Specialties

For new pumping equipment guaranteed by people who will make good, phone, wire or write the above.
Sales Agents for UNION STEAM PUMP CO.



Standpipes
Water Tanks
Gas Holders
and all other metal surfaces need the protection of
DIXON'S
Silica-Graphite
PAINT
BOOKLET NO. 67-B
JOSEPH DIXON CRUCIBLE CO. Jersey City, N. J.

DE LAVAL



Typical Small Electrically Operated Centrifugal Municipal Water Works Installation.

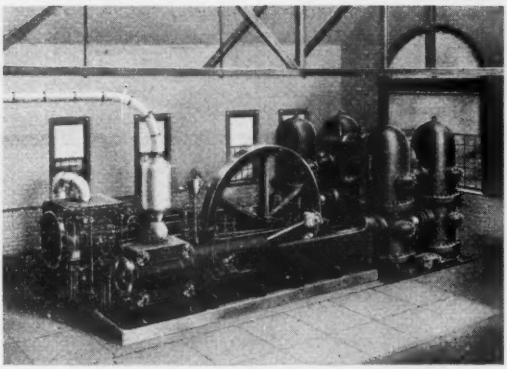
POWER EQUIPMENT COMPANY
BOSTON

MURRAY IRON WORKS CO.

(INCORPORATED 1870)

BURLINGTON, IOWA, U. S. A.

Builders of High Duty Pumping Engines



Murray High Duty Crank and Fly Wheel Pumping Engine, Opposed Type

Engineers, Iron Founders, Boiler Makers

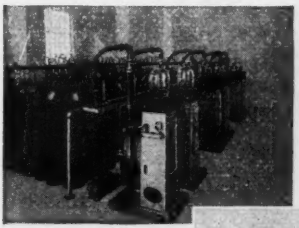
Corliss and Una-Flow Engines

Water-Tube, Fire-Tube and Internal-Furnace Boilers

Builders of Complete Power Plants

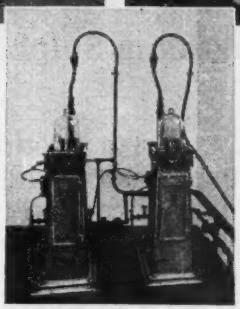
PLEASE SEND US YOUR SPECIFICATIONS AND CALLS FOR BIDS

Chlorine in Sewage Purification



At the Westerly Sewage Disposal Works at Cleveland, six Pedestal Type Chlorinators are installed to chlorinate the Imhoff Tank Effluent.

Eighteen Pedestal Type Chlorinators installed at the Easterly Sewage Disposal Works, Cleveland, Ohio. "The Largest Chlorinator installation in the World." Capacity six and one-half Tons of Liquid Chlorine a day.



New York City uses the Pedestal Type Chlorinator at the Midland Beach Sewage Disposal Plant.

NOT ONLY has the Chlorination of water become standard practice in a large portion of the world but the value of Chlorine in Sewage Purification as a germicide, deodorant, and oxidizing agent is increasingly evident.

Sanitarians recognize that disease laden sewage should not be discharged into water used for drinking or bathing until the harmful germ life in the sewage has been destroyed.

Here W&T apparatus is particularly applicable. We invite inquiries concerning the use of our equipment in the Purification of Sewage.

"The only safe Water is a Sterilized Water"

TECHNICAL PUBLICATION NUMBER 42 "CHLORINE IN SEWAGE PURIFICATION" WILL BE MAILED ON REQUEST

WALLACE & TIERNAN
COMPANY, INCORPORATED
Manufacturers of Chlorine Control Apparatus
NEWARK NEW JERSEY

Founded 1853 Incorporated 1863

MERRIMAC CHEMICAL COMPANY 1863

FILTER ALUM

Aluminum Sulphate

A basic, uniform product which has been used successfully by the leading water filtration plants in New England for many years.

Our location and shipping facilities place us in a position to offer insurpassable service and make us the logical source of supply for all filter plants in New England.

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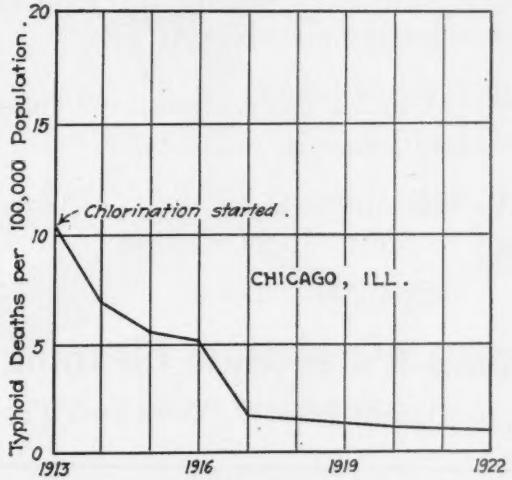

DIAGRAM SHOWS REDUCTION IN TYPHOID FEVER DEATH RATE AFTER INSTALLATION OF CHLORINE

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WHITE MOUNTAIN BRAND LIQUID CHLORINE

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ESTABLISHED 1848

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Water delivered through dirty pipes
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Incrusted water pipes mean inefficiency
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We Guarantee the Results of Our
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WRITE US.

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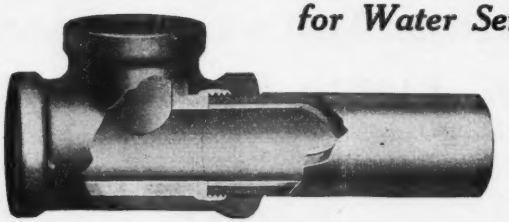
CEMENT LINED IRON PIPE
for Water Service



The "RESISTO" Process ensures the safest and most dependable material for water service lines. Absolutely tight joints. No opportunity for corrosion.

Write us for details and prices

Manufactured by

Resisto Pipe & Valve Company

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A Simple Question of Arithmetic

The cost of a length of service pipe is trifling compared with the cost of laying it. In case of failure of the pipe, the loss of water, labor of digging up and renewing a pipe, still further multiplies the installation cost.

The lasting quality of the pipe, depending on its rust-resistance, is therefore the first thing to be considered by the majority of experienced water works engineers and superintendents. Hence the extensive use of Byers pipe for underground water service.

The chemical and physical properties of genuine wrought-iron and their bearing on the question of rust-resistance, are interestingly dealt with in Byers Bulletin No. 6-A. Write to A. M. Byers Company, Pittsburgh, Pa., for a free copy.

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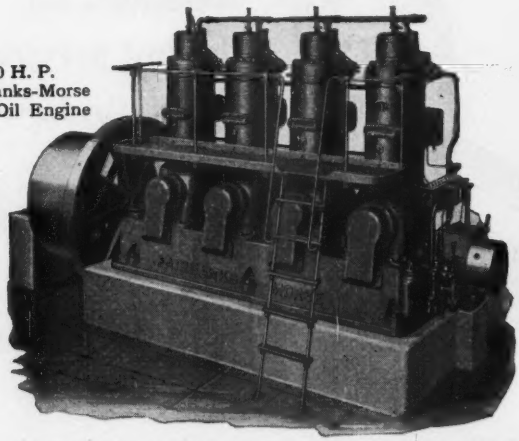
GENUINE WROUGHT IRON

Look for the Name and Year rolled in every length

Over 90,000 H. P. in use

for Pumping only



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Fairbanks-Morse
"Y" Oil Engine

Municipal pumping station records in towns and cities throughout the United States, prove the economy of Fairbanks-Morse "Y" Oil Engines. These plants now use a total of more than 90,000 H. P. of these engines, entirely for pumping purposes.

"Y" Oil Engines use any low-grade crude or fuel oils. They start easily; full power can be had any time in five minutes. There is no expense when engine is not operating. There are no igniters, timers, wires, carburetors, hot bulbs or water injectors. Engineers like to operate them because they leave more time free for care of other equipment. Users report savings in comparison with hydro-electric and steam, of from 50 to 75 per cent.

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Fairbanks-Morse Pumps can be furnished in either centrifugal or piston types; motor, steam or oil-engine drive; either belted or direct connected. A wide range of models and sizes meets every requirement and condition.

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Manufacturers of the well-known CLARK METER BOX, maintaining uniformity for both large and small meters. Standardization in meter installations saves you money. Everything for the Water Works.

Write for new catalogue No. 20.

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Quotations furnished promptly for shipment from Foundry

CEMENT LINED SERVICE PIPE
With Specially Adapted Lead-lined Fittings
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PUMPING ENGINES

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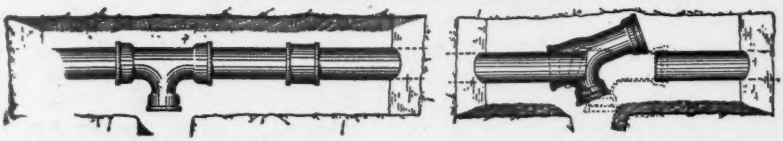
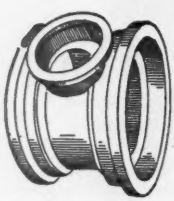


Old Way *Our Way*



Connections economically and easily made with one fitting. Saves sleeve, cuts, lead and unnecessary work and material.

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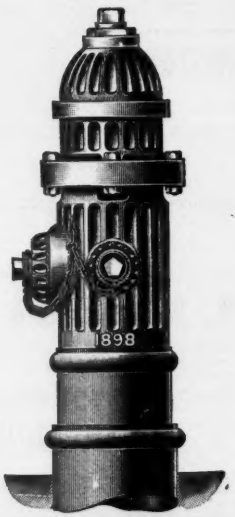
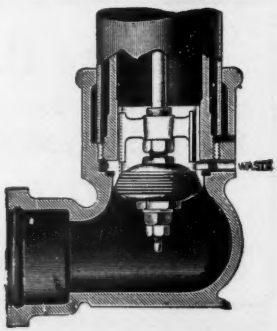
Cost of fittings reduced from 25% to 50%. Full strength. Deep bells. Convenient to handle. Sold by the piece.



Mathews Fire Hydrants

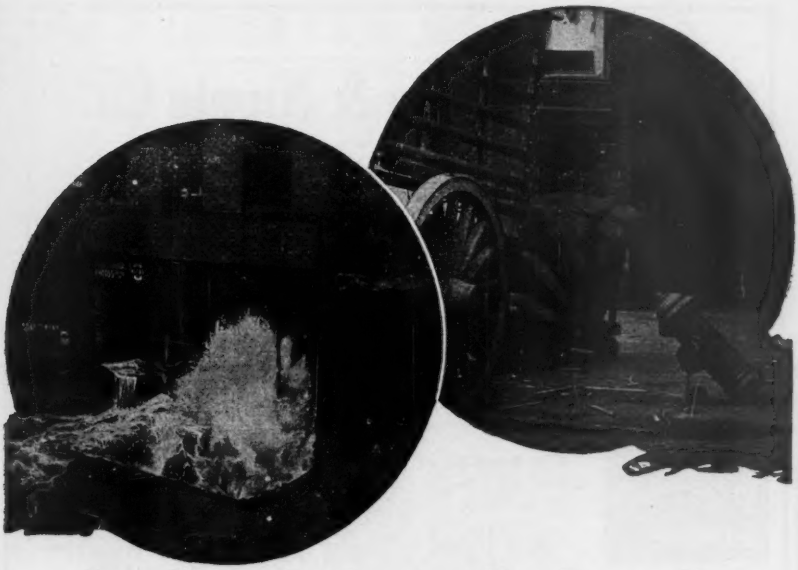
A half century of use has established their reputation as being the most economical, durable and simple hydrant.

Number in use exceeds total of all other makes combined.



Gate Valves

R. D. WOOD & CO. STANDARD
DOUBLE DISK
ANTI-FRICTION
EXTRA WEIGHT, FINISH
AND MATERIAL



Are Your hydrants flood proof?

Accidents will happen. And the exposed position of a fire hydrant renders it particularly subject to mishaps which, unless properly provided against, cause loss of water, property damage and even danger to life.

The Kennedy "Newtype" Fire Hydrant is designed to automatically and effectively prevent loss of water and consequent damage due to flooding or breaking. This advantage is secured without special mechanism in the "Newtype" Fire Hydrant so that even after a long period of inaction its operation is assured.

The flood-proof feature is only a single one of the many special characteristics of the Kennedy "Newtype" Fire Hydrant. Its construction also eliminates danger of breakage from freezing, permits easy inspection and removal of internal working parts without in any way disturbing the standpipe, digging up the street or disconnecting the main, and assures low service cost by simplicity, interchangeability and high quality. Our Hydrant Bulletin fully explains these features. Send for it.

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We make **Pressure Regulating Valves** for all purposes, steam or water.

Our **Feed-Water Filter** will keep oil out of your boiler.

We can interest you if you use a condenser.

Water Engines for Pumping Organs

THE ROSS VALVE MFG. CO.

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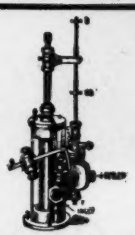

Standard for pumping church or parlor organs. Ask your organ builder for it or write us.

Coffin Valve Co.

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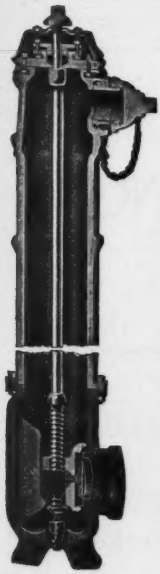
Sluice Gates, Gate Valves and Fire Hydrants



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This hydrant is anti-freezing, because when the drainage is good no water is left in it to freeze.

The drip is directly in the bottom of the hydrant and drains perfectly. It is protected by its valve, which never leaves its socket and cannot be clogged.

DOUBLE AND SINGLE GATE **VALVES,**

ALSO CHECK **VALVES,**

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FIRE HYDRANTS.

YARD, WASH, AND FLUSH HYDRANTS.

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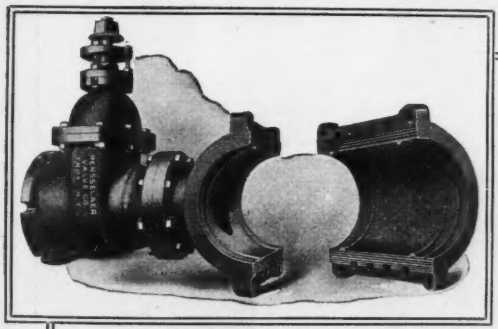
82 GOLD ST.	HARRISON BLDG.	112 WATER ST.	1ST NAT. BANK BLDG.	THE ROOKERY	R. A. LONG BLDG.



Rensselaer Tapping Sleeves

were brought out to meet a growing demand for a "BETTER" Tapping Sleeve. They were designed to suit conditions met in actual practice.

They can be used with all standard makes of Tapping Machines.

POINTS OF
SUPERIORITY

Have two lead rings.

Require less lead for calking.

Iron washers not required.

Bolting flanges are made full length of sleeve, giving great strength.

Have greater thickness of hubs on ends.

Easier to center on pipe before pouring lead.

Cost less to install.

Book No. 11 gives full information.

Ask for prices.

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Manufacturers of

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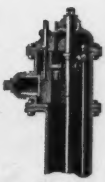
WATERFORD, NEW YORK U.S.A.

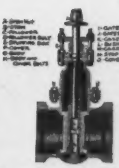
PATENT RUBBER FACED

EDDY FIRE HYDRANT

Section of Taper Seat-Valve.



Hydrant with Independent Nozzle Cut-off.



Section of Parallel Seat-Valve.

Section of Vertical Check-Valve.

Section of Vertical Foot-Valve.

Horizontal Check-Valve.

Vertical Foot-Valve.

Hydrant with Water Crane Attachment.

Indicator Post.

Water Crane with Automatic Drip Valve.

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All Goods made by the EDDY VALVE COMPANY are manufactured exclusively at WATERFORD, N.Y., U.S.A.

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MANUFACTURERS
...OF...

CAST IRON PIPE

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Special Castings for Water and Gas.
Also Flange Pipe, Street Castings,
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Is your per capita consumption too high?

Do you account for less than 85% of your pumpage?

Are you receiving full revenue from your manufacturing consumers?

If any of these problems confront you, write us at once, without obligation, and let us tell you about our PITOMETER SURVEYS.

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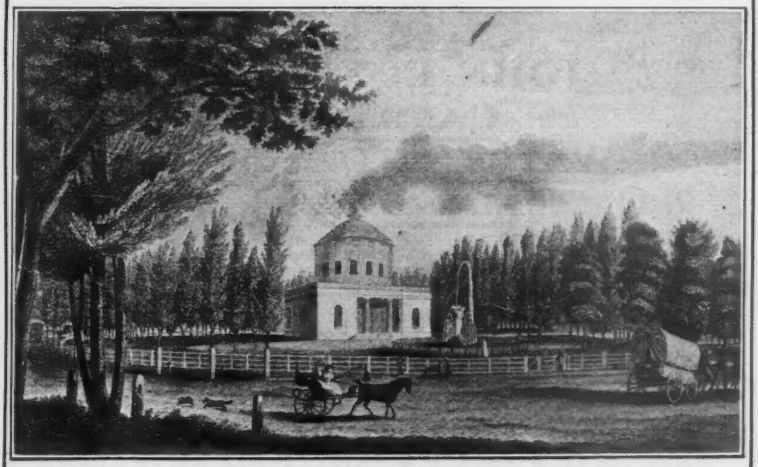
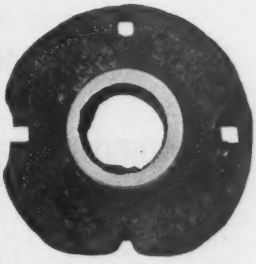
Philadelphia is most bountifully provided with fresh water, which is showered and jerked about, and turned on, and poured off, everywhere. The water-works, which are on a height near the city, are no less ornamental than useful, being tastefully laid out as a public garden, and kept in the best and neatest order. The river is dammed at this point, and forced by its own power into certain high tanks or reservoirs, whence the whole city, to the top stories of the houses, is supplied at a very trifling expense.

— "*American Notes*" *by Charles Dickens.*



Old Pumping Station, Philadelphia

In 1842 Charles Dickens wrote the above description of the Philadelphia Water Works. At that time cast iron pipe, in Philadelphia, had been delivering water faithfully for 25 years. Nor was its usefulness nearly over. In 1915 the pipe illustrated was removed, though still in good condition after almost a century of service, to make way for a line of larger capacity.



Section of 1817 line

Write to the Publicity Department, Burlington, for booklet "98 Years of Excellent Service."

United States Cast Iron Pipe & Foundry Co.

General Office: **Burlington, New Jersey**

THE A. P. SMITH MANUFACTURING CO.

EAST ORANGE, N. J.

Manufacturers of

Tapping Machines, Fire Hydrants, Water Gates,

Economic Lead Furnaces,

Corporation and Curb Cocks, Brass and Aluminum Castings.

Also General Supplies for Water and Gas Works.

Write for Catalogue.

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WATER & GAS PIPES

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Special Castings, Fire Hydrants, Valves

General Foundry and Machine Work

WOOLWORTH BUILDING 233 BROADWAY

NEW YORK CITY

HIGHEST AWARD, GOLD MEDAL,
ST. LOUIS EXPOSITION, 1904

Over 100 Water Departments

use

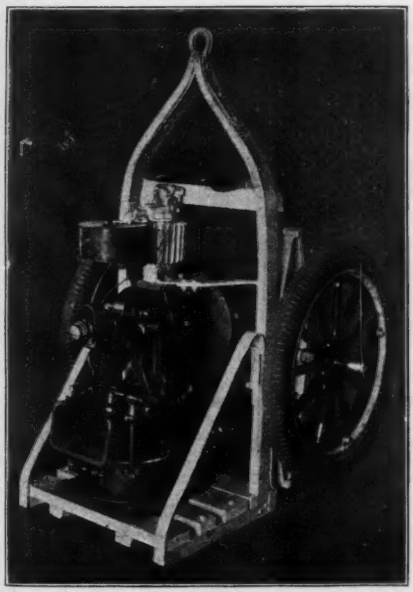
LEAD-LINED IRON and TIN-LINED PIPES

for their service connections

MANUFACTURED BY

Lead Lined Iron Pipe Company

Wakefield ═══ Mass.



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Twelve Reasons Why

YOU SHOULD USE

Trade "LEADITE" Mark

Registered U. S. Patent Office

FOR

Jointing Water Mains

1. **DURABILITY.** Leadite joints increase in strength with age.
2. **NO CAULKING.** Leadite joints require no caulking, because the Leadite adheres to the pipe, making a water-tight bond.
3. **COMPARATIVE QUANTITIES.** One ton of Leadite is equivalent to four tons of lead.
4. **LABOR SAVING.** Saves caulking charges and digging of large bell-holes, and reduces the cost of trench pumping to the minimum.
5. **COST.** Its use saves 50 to 65 per cent. over lead, owing to the saving effected in material and labor.
6. **TOOLS.** As no caulking is required, fewer tools are needed.
7. **TRANSPORTATION.** Considerable freight charges are saved because Leadite is lighter than lead.
8. **HAULING.** Saves hauling expense on the work because you move only one fourth the weight of jointing material.
9. **FUEL.** Saves fuel because you melt only one ton of material instead of four, and not as much heat is required either.
10. **DELIVERY.** We can make prompt shipments.
11. **DAMAGE SUITS.** Claims for damages caused by joints blowing out are prevented because Leadite joints will not blow out under any pressure.
12. **USERS.** Progressive water works all over the country use Leadite.

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LAND TITLE BUILDING PHILADELPHIA

Chadwick-Boston Lead Co.

162 Congress St., Boston

Agents for

The Celebrated "ULCO"

LEAD WOOL

(Every Atom Pure Lead)

For calking pipe joints under the most difficult conditions.

For overhead joints, or in wet places where the use of molten lead is not only impracticable but dangerous — **LEAD WOOL** may be used to advantage.

It makes an absolutely tight joint which will withstand the highest pressure, yet be sufficiently elastic to allow considerable sagging or settling of the pipe without danger of a leak.

As compared with the poured joint, in this respect, the superiority of **LEAD WOOL** is apparent.

Manufacturers of

Lead Pipe, Tin Lined Lead Pipe, Pure Block-Tin Pipe, Solder, White Lead and Red Lead.

HIGHEST QUALITY SOFT BRANDS

PIG LEAD

TEN CENTS PER POUND PRICE TEN CENTS PER POUND PRICE TEN CENTS PER POUND TEN CENTS

Join Your Water Mains

WITH

LEAD-HYDRO-TITE

TRADEMARK

AND CUT YOUR EXPENSES

50% FIRST COST

50% SMALLER BELL HOLES

75% HANDLING

100% CALKING

OUR PROPOSAL

That the prospective users purchase a trial lot of 1 to 5 bags, and that this be used under the direction and according to the instructions of our representative.

If, after a trial, the purchaser is not satisfied with the material, any surplus not in use to be returned to the Lead-Hydro-Tite Company, and no charge to be made for any of the Lead-Hydro-Tite furnished.

Owned, Manufactured and Sold by New Englanders

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TEN CENTS PER POUND PRICE TEN CENTS PER POUND PRICE TEN CENTS PER POUND TEN CENTS

"The Goods That Please"

Corporation and Curb Cocks

We have them to meet every requirement

ORIGINAL

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Extension Service Boxes of proven advantages

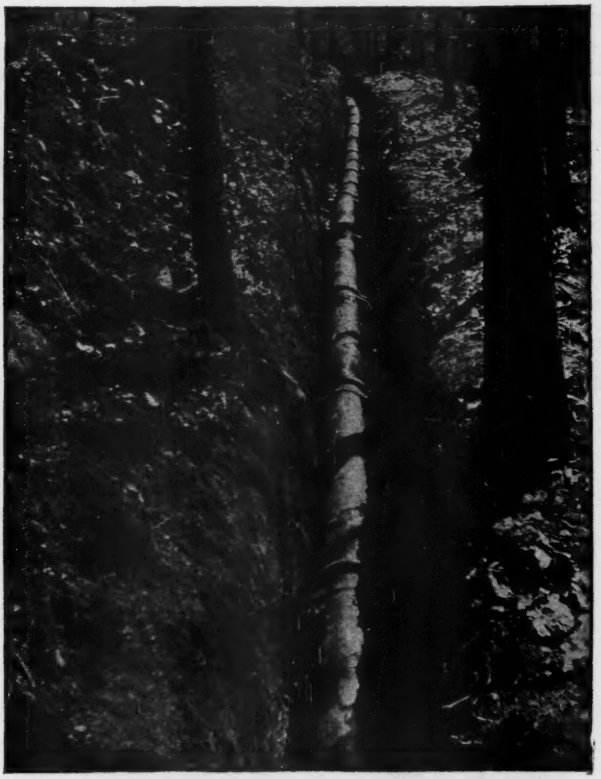
Let us send at our risk, on 30 days' trial, a

Payne's Patent Tapping Machine

which is recognized to be the most easily operated owing to the few working parts.

Hays Mfg. Co., ERIE PENNSYLVANIA

Established 1869



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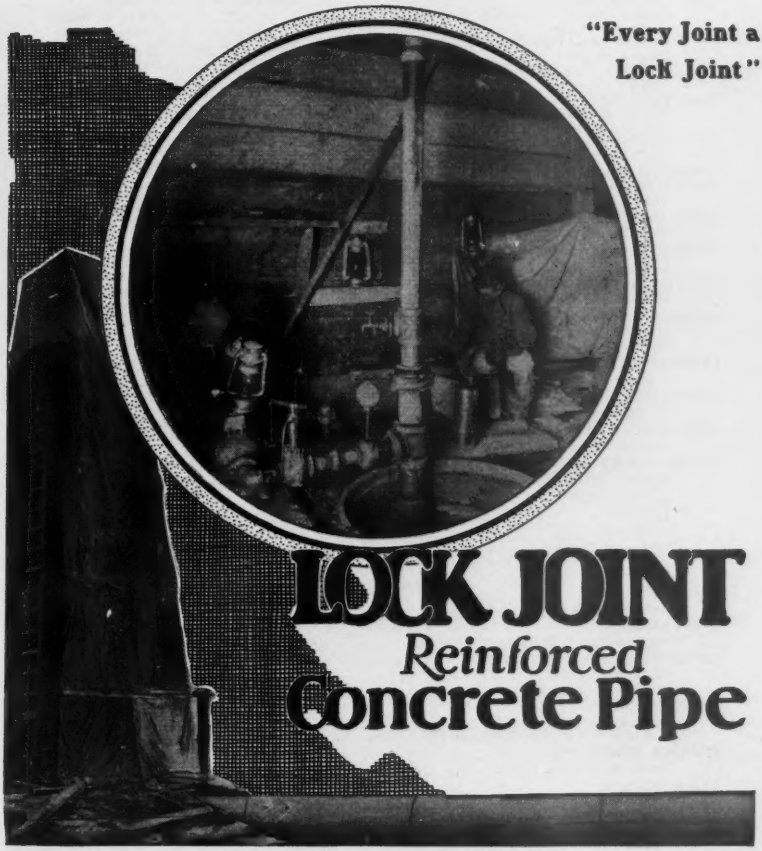

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Pressure, Sewer, Culvert and Subaqueous Pipe

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